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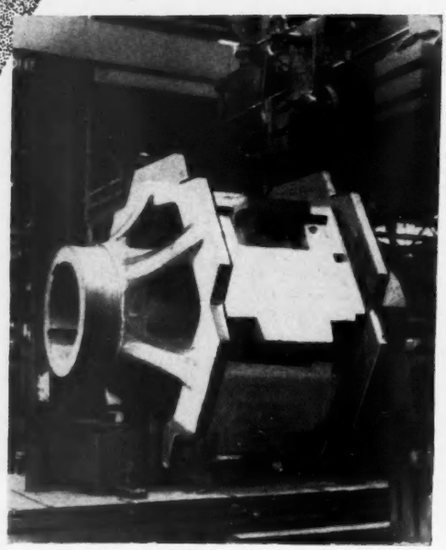
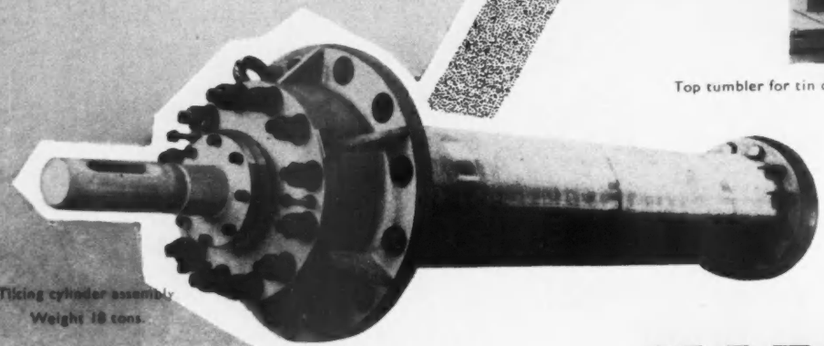


Top tumbler for tin dredging. Weight 17½ tons.



Tilting cylinder assembly Weight 18 tons.

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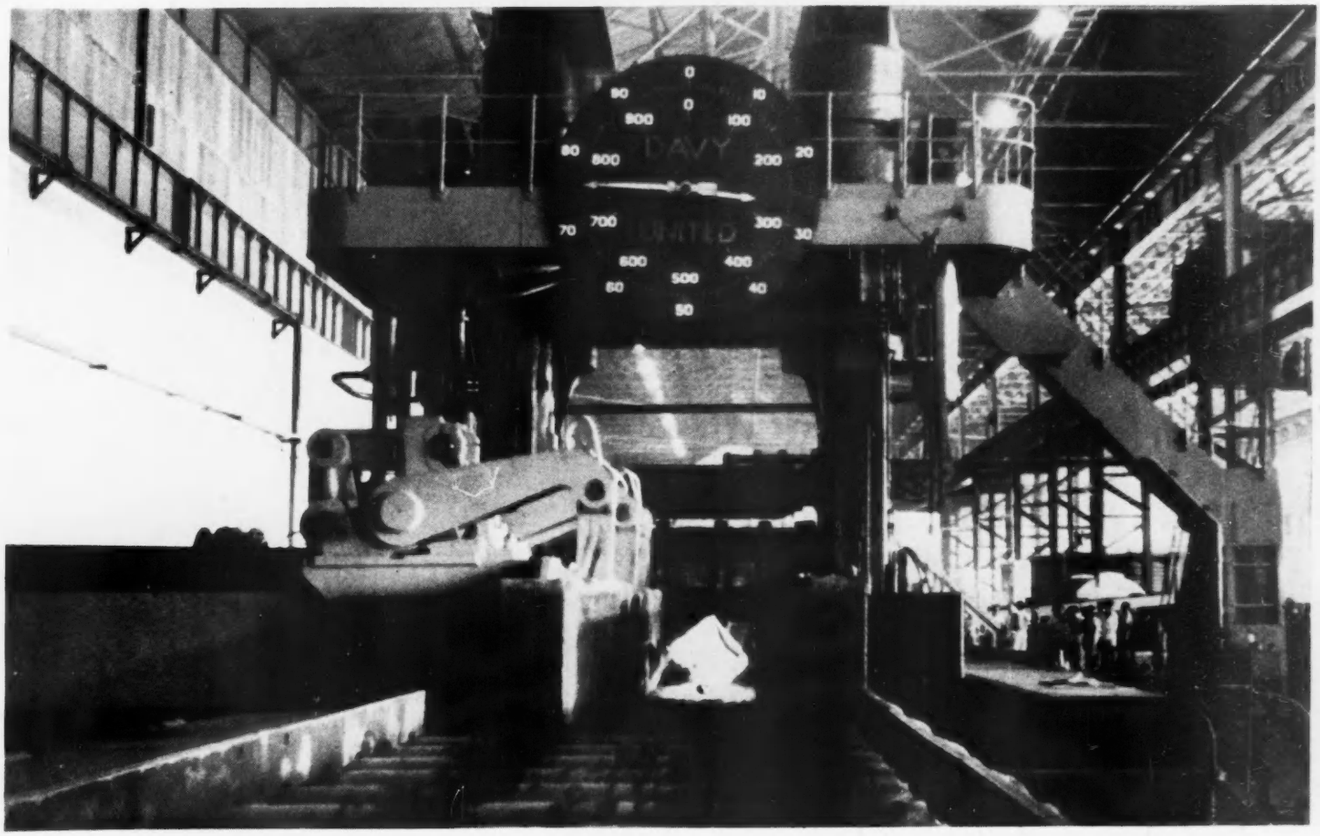

After 3½ years of building, the new Durgapur Steelworks in West Bengal is in production.

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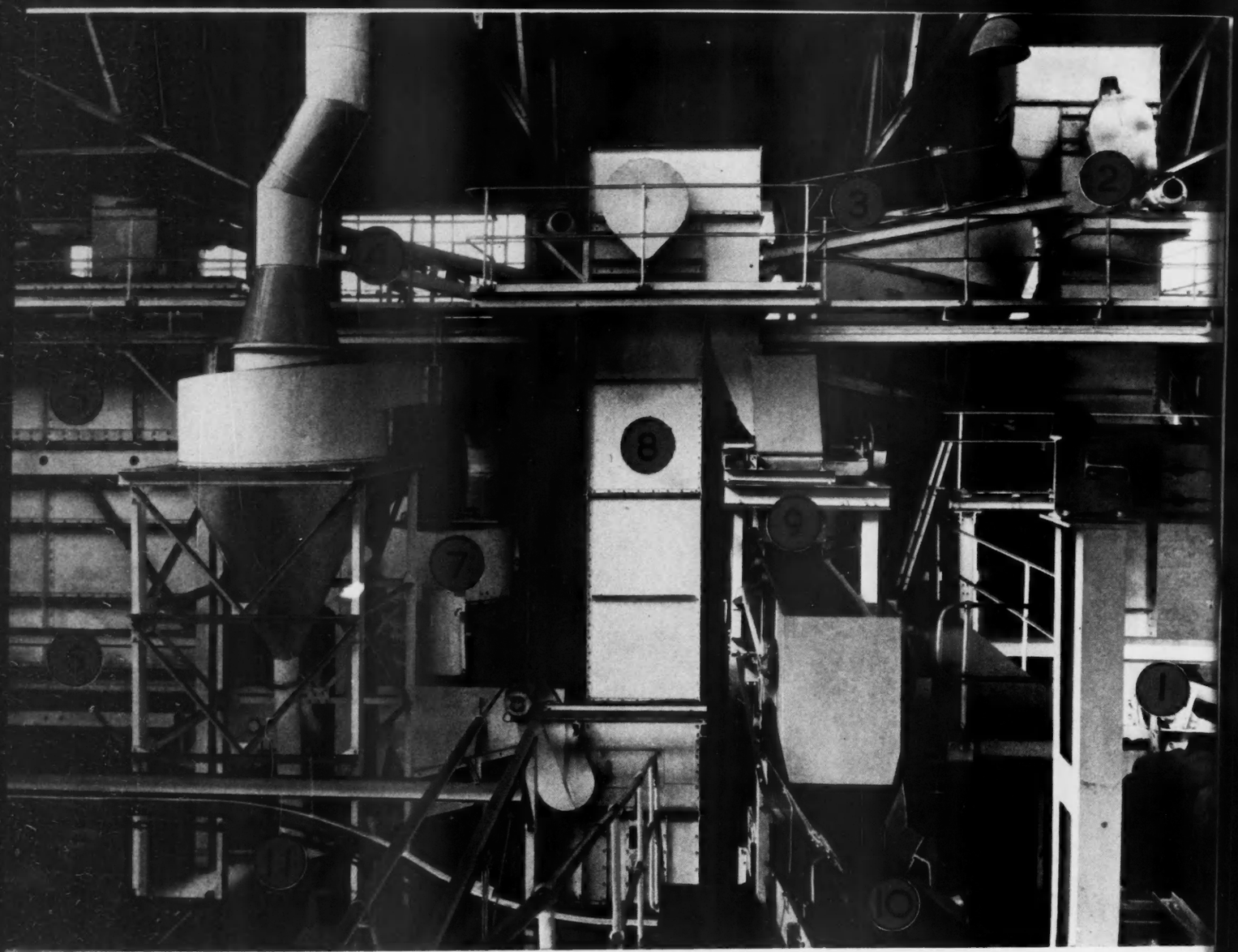

The illustration shows that part of a **MORRIS** foundry sand and mechanization plant which re-conditions knocked-out sand. At **1**, sand coming from the knock-out via an apron plate and belt conveyor passes beneath a magnetic separator (to remove tramp iron) and falls into the boot of a belt-bucket elevator, **2**, discharging into screen **3** onto belt conveyor **4** which in turn discharges into sixty-ton storage hopper **5**. The flat belt conveyor, **6**, under the hopper, pours sand into the skip which feeds the mulling machine (known as the Speedmullor). This machine **7**, providing a rapid mulling cycle with close batch control, discharges the sand into belt-bucket elevator **8**. From thence, the sand proceeds via belt conveyors **9** and **10** to the moulders. The overhead chain conveyor **11** serves the core shop with sand and also takes the cores to the stoves and to the moulders.

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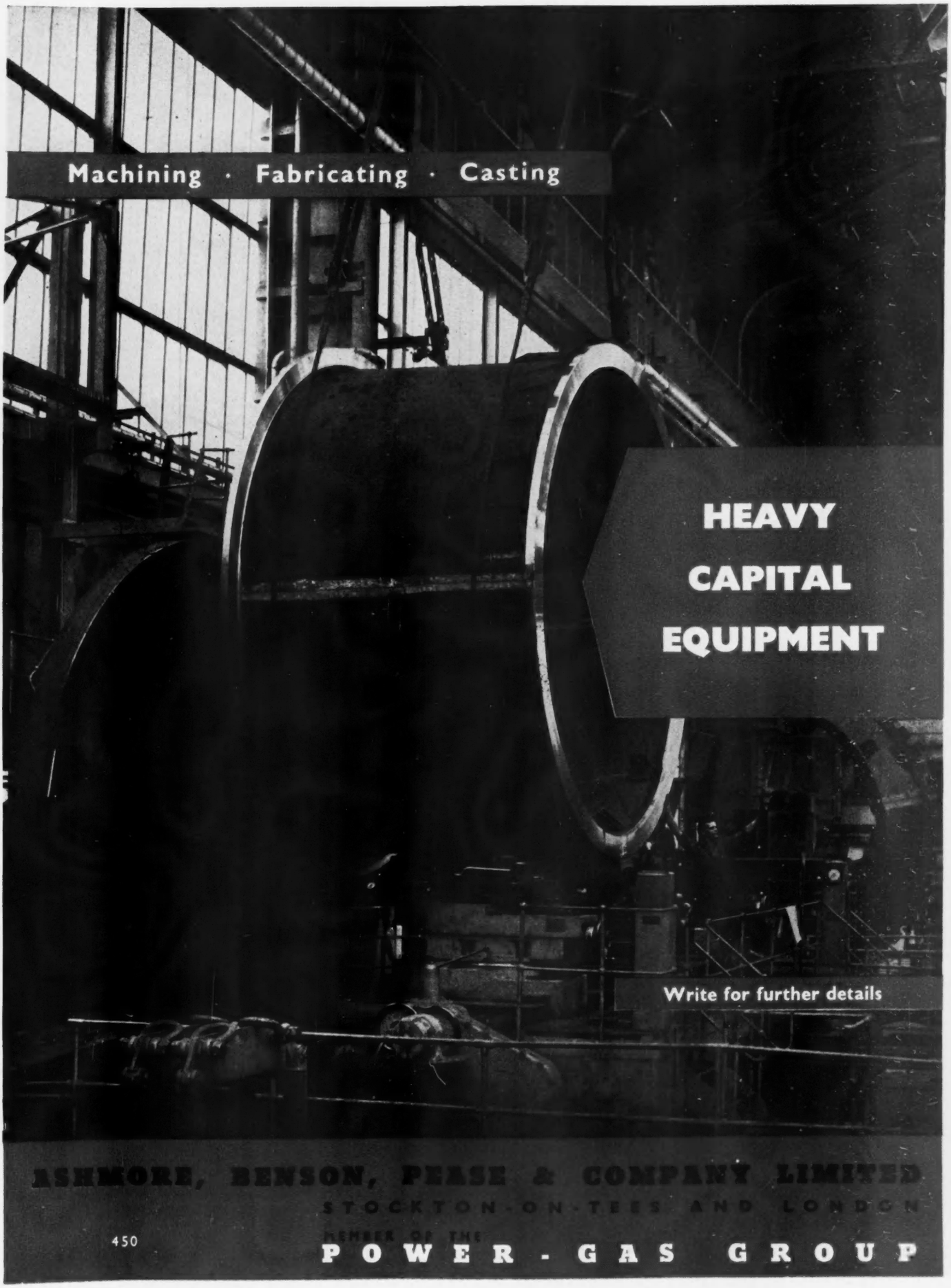
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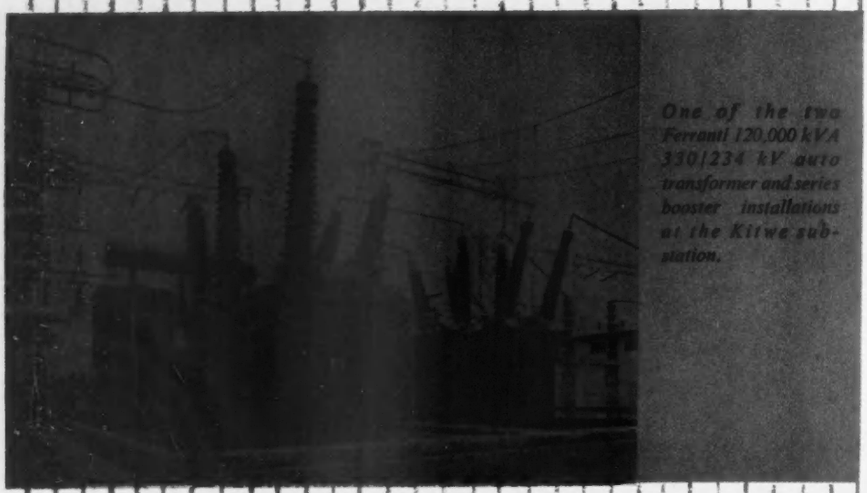
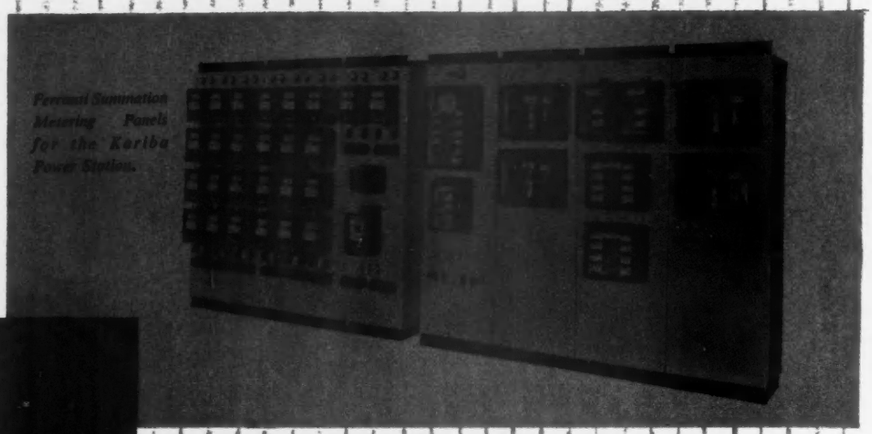
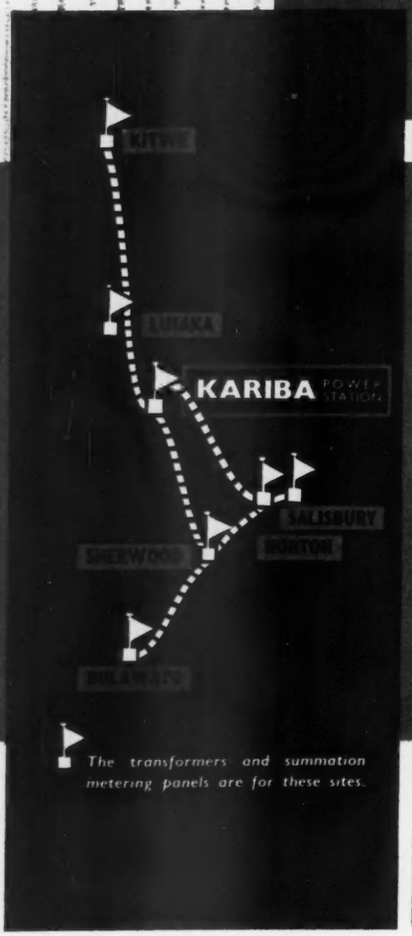


One of the two Ferranti 120,000 kVA 330/234 kV auto transformer and series booster installations at the Kitwe sub-station.

FERRANTI at KARIBA



Ferranti Summation Metering Panels for the Kariba Power Station.



The transformers and summation metering panels are for these sites.

TRANSFORMERS

All the sub-station transformers for the Kariba Hydro-Electric Scheme are being supplied by Ferranti Ltd. They comprise two 120,000 kVA, 330/234 kV 3-phase auto transformers with series boosters, eight 60,000 kVA, 330/88kV and four 60,000 kVA, 330/33 kV 3-phase double wound transformers. The transformer installations at Norton, Lusaka and Kitwe are complete. Work at Salisbury, Bulawayo and Sherwood is well advanced.

SUMMATION METERING

For the same scheme Ferranti Ltd. are supplying Summation Metering Equipment comprising: Precision grade integrating meters, Electro-mechanical summators, Printometer Demand Recorders and Suites of metering cubicles. These equipments will be used to meter six 100 MW generator sets at Kariba Power Station and also the supplies to the Transforming Stations at Kitwe, Norton, Salisbury, Lusaka, Sherwood and Bulawayo.

The consulting electrical and mechanical engineers are Messrs. Merz & McLellan.

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A late stage in the erection of an engine—fitting the sheet metal cowls and manifolds on a twin cylinder engine. (*Nurnberg photograph for* ENGINEERING)

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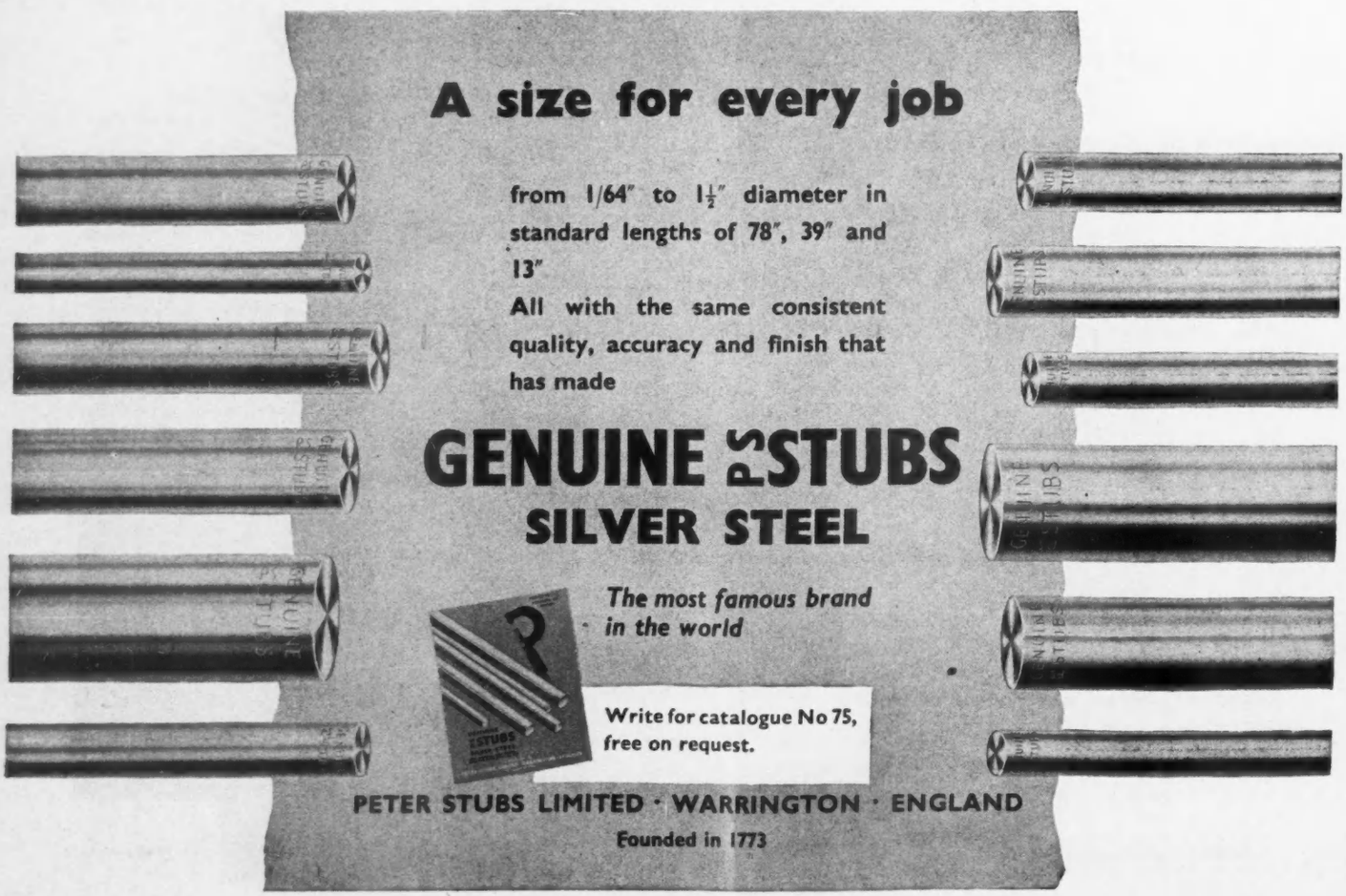
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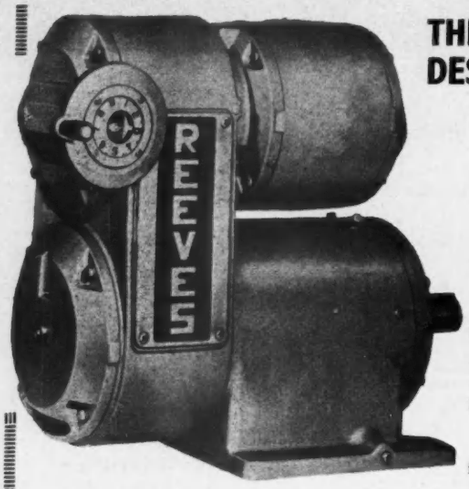

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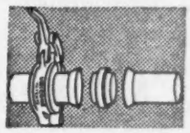
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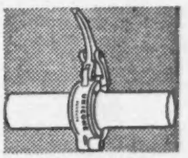
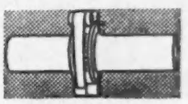

Pipe ends joined ready for locking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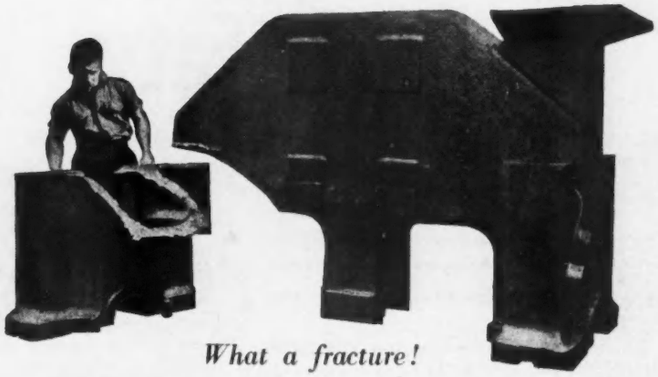
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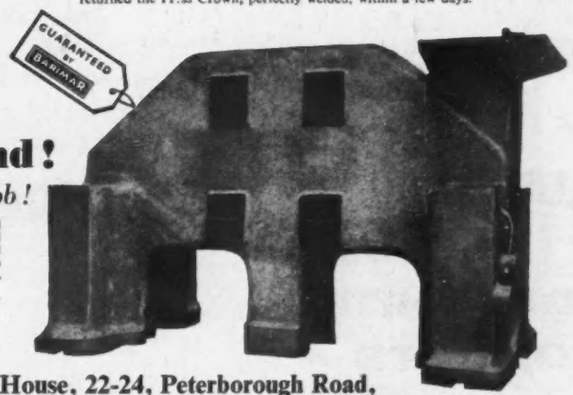

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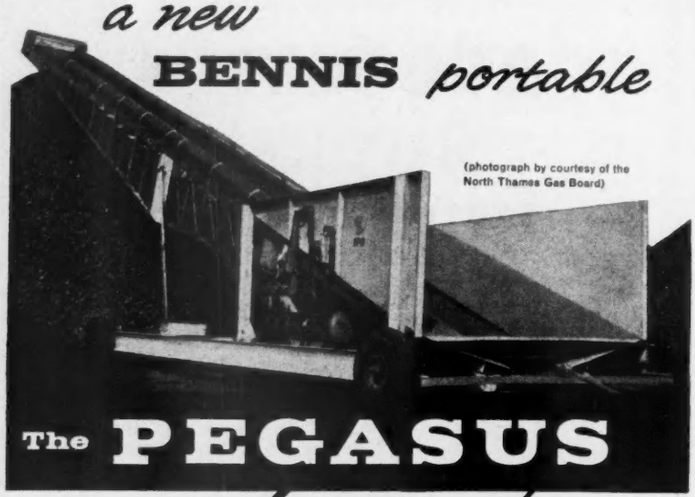

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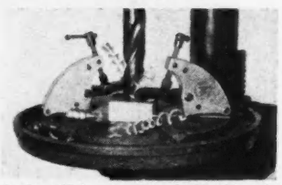

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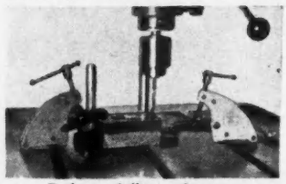

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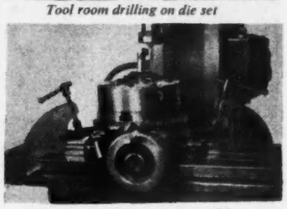

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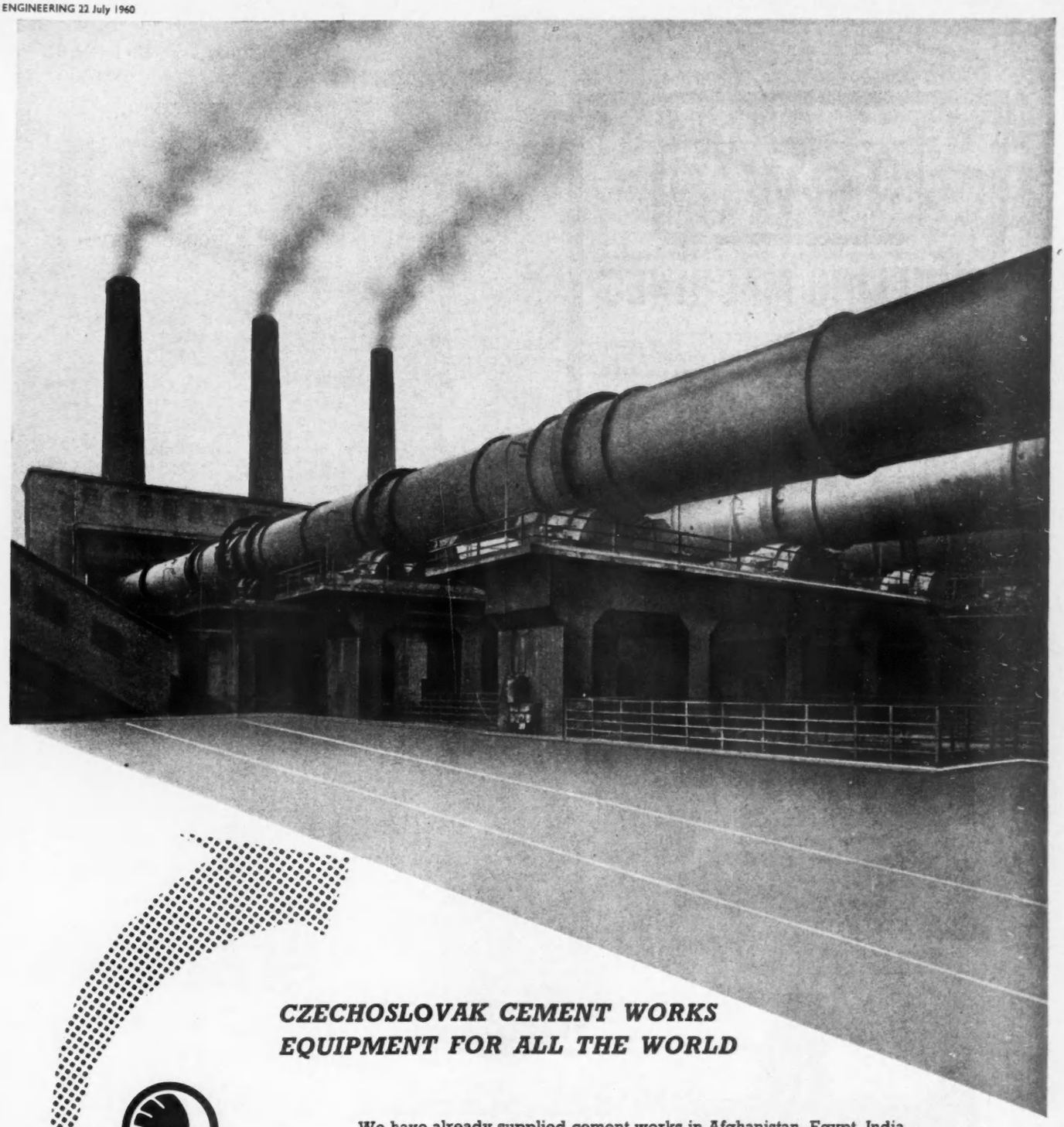

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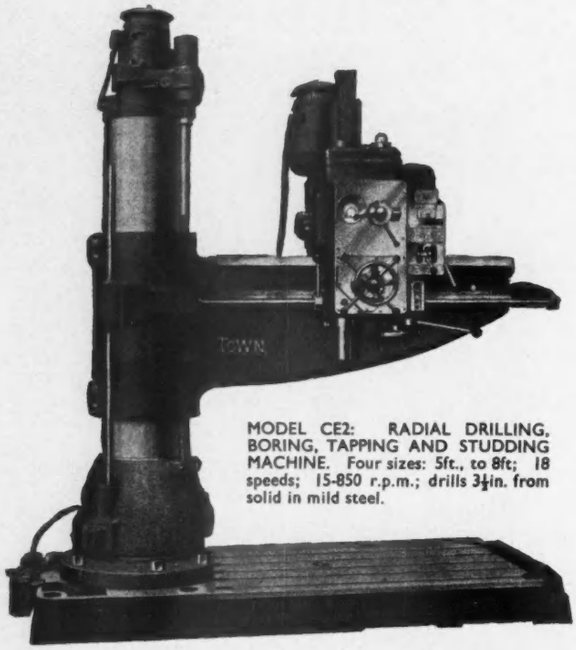

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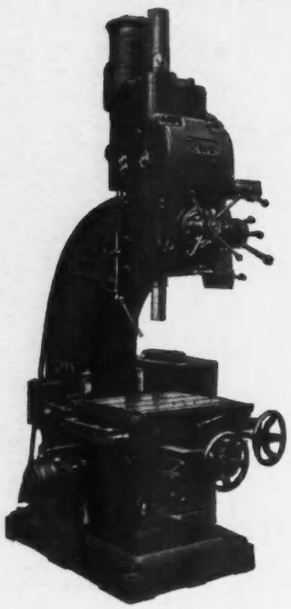

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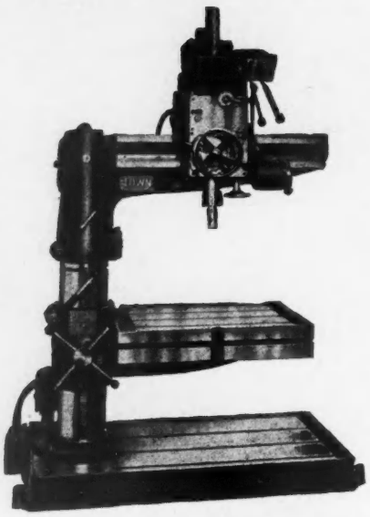

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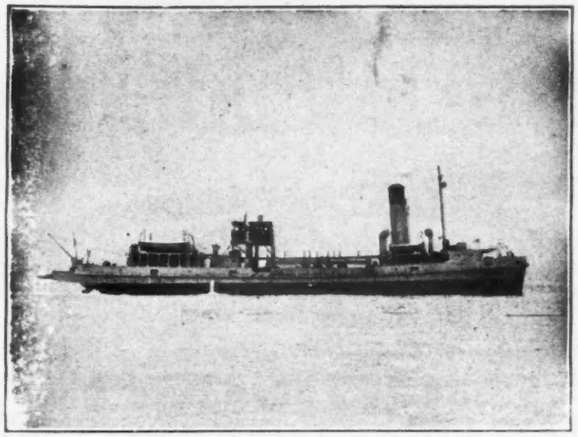

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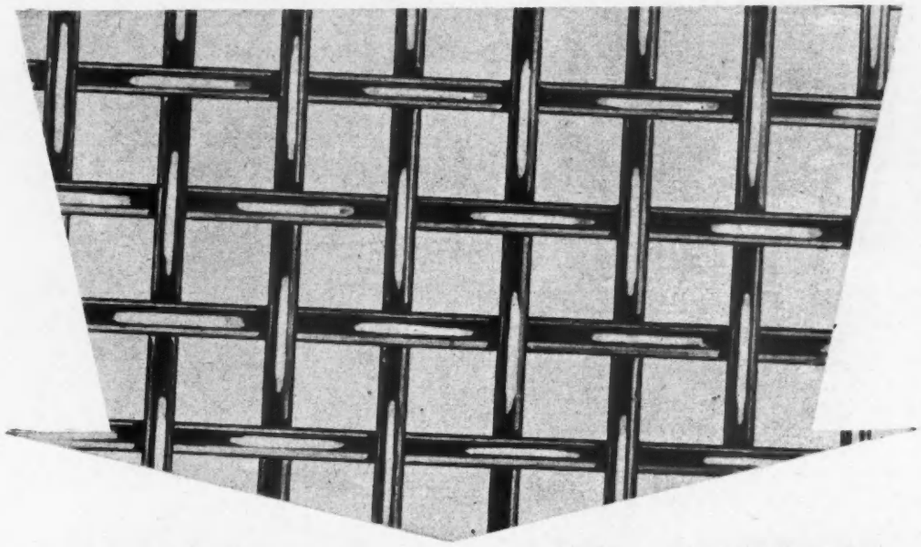

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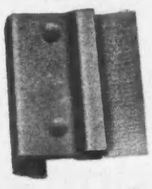

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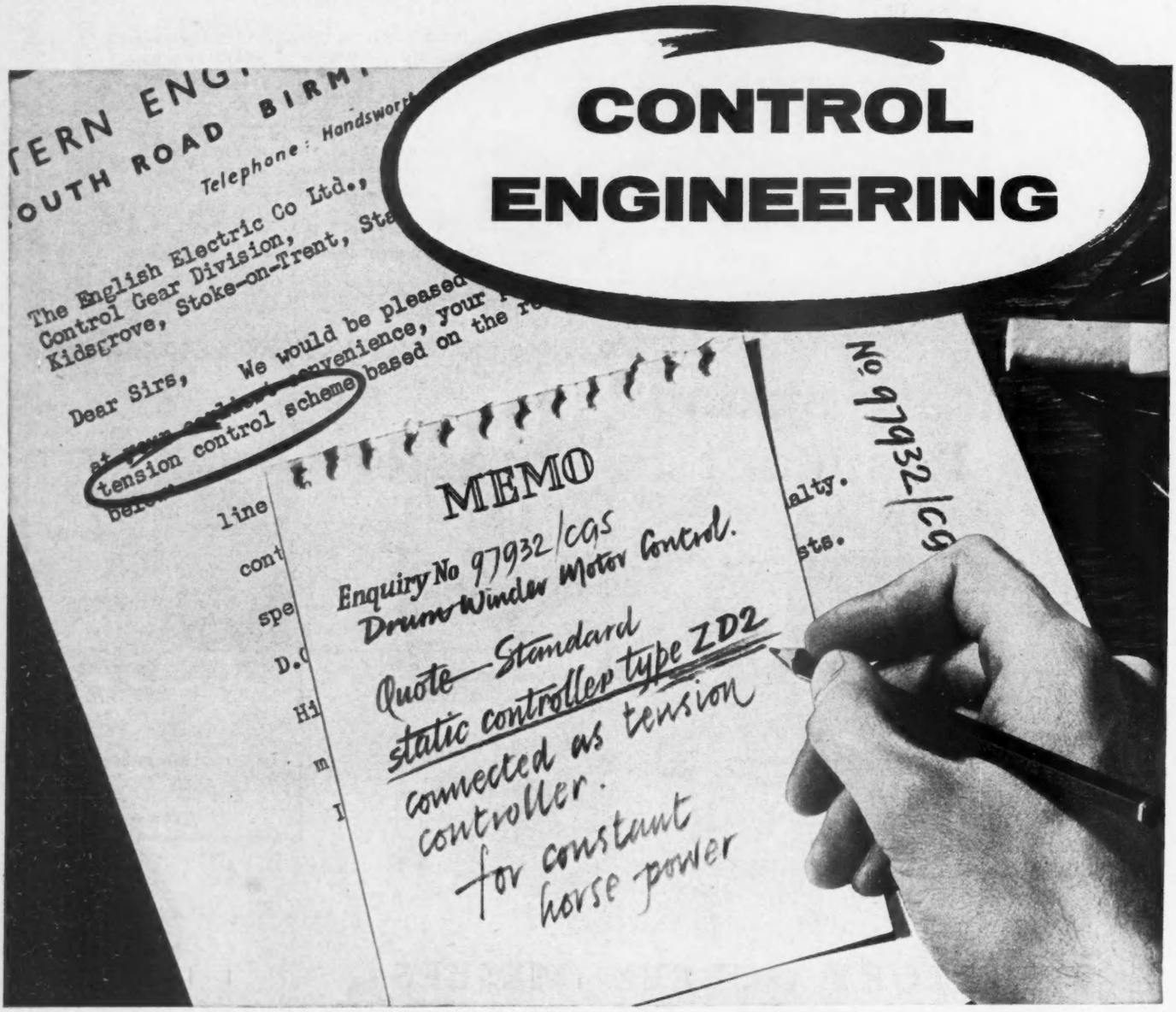

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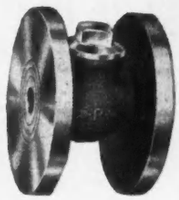

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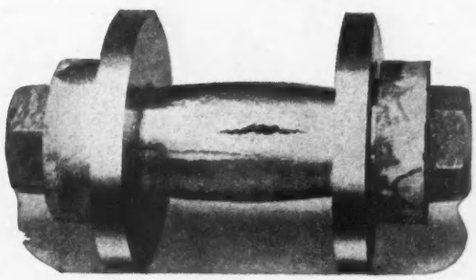
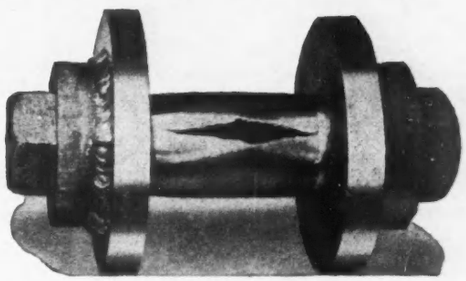


Gun-metal **0·25 in.** *thick—burst at 4480 lbs. per sq. in.*



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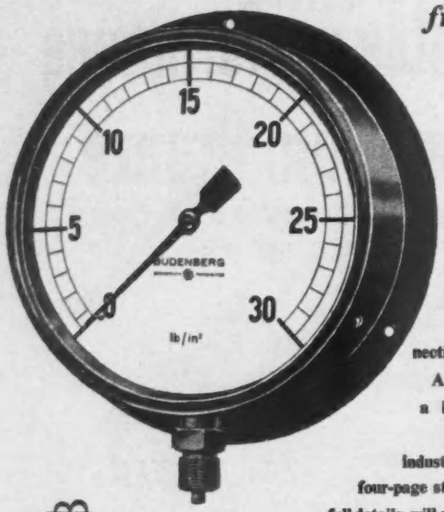

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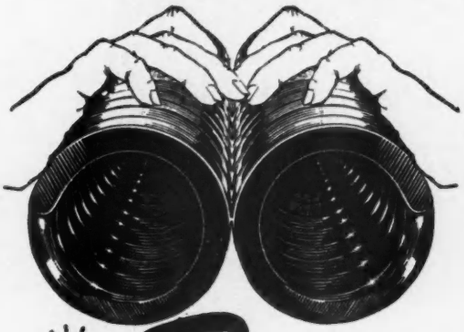

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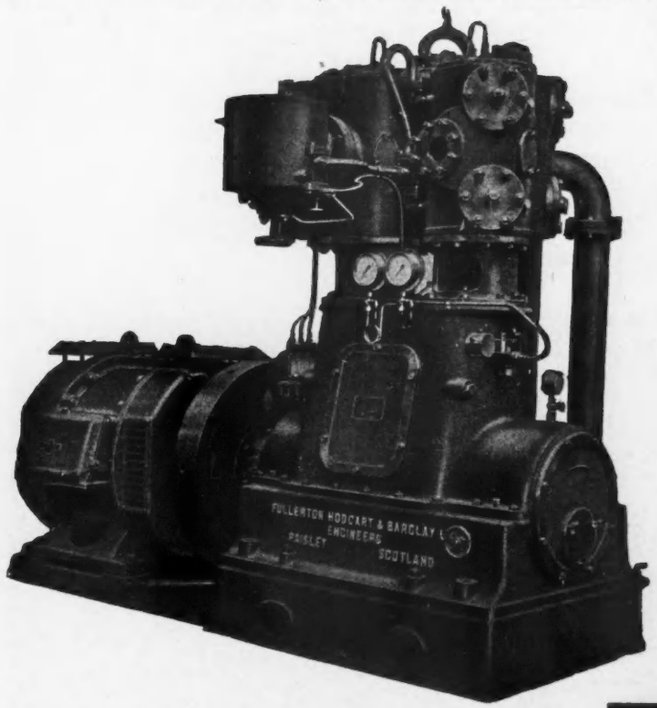

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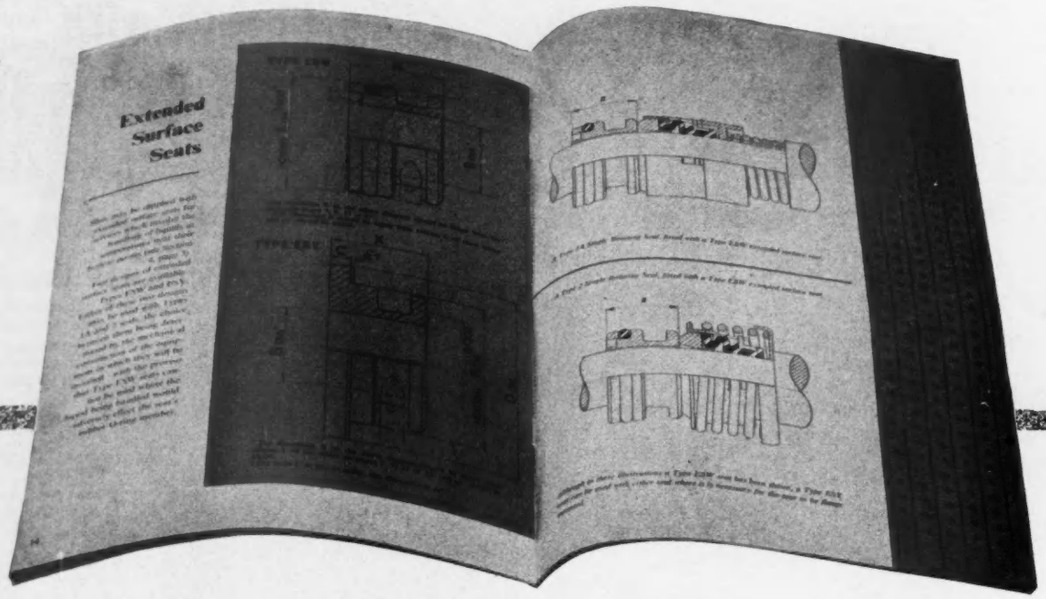

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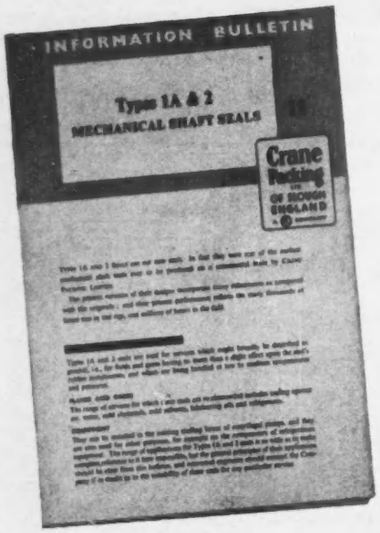

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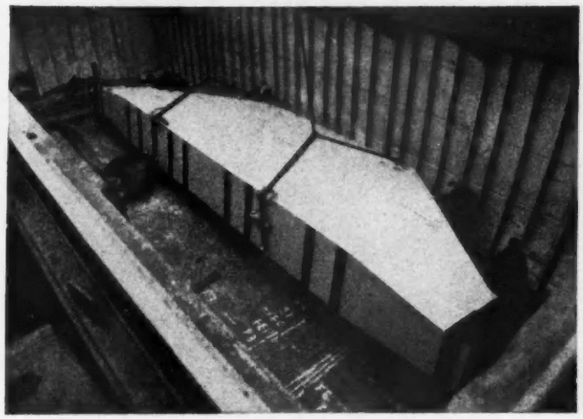

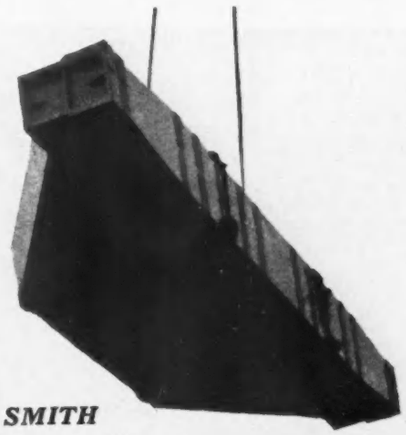

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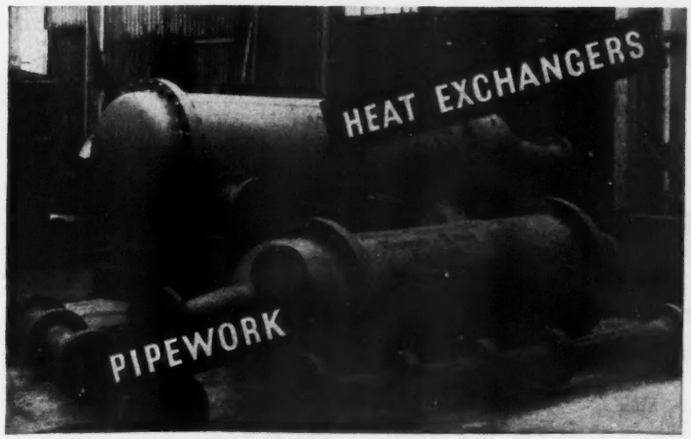

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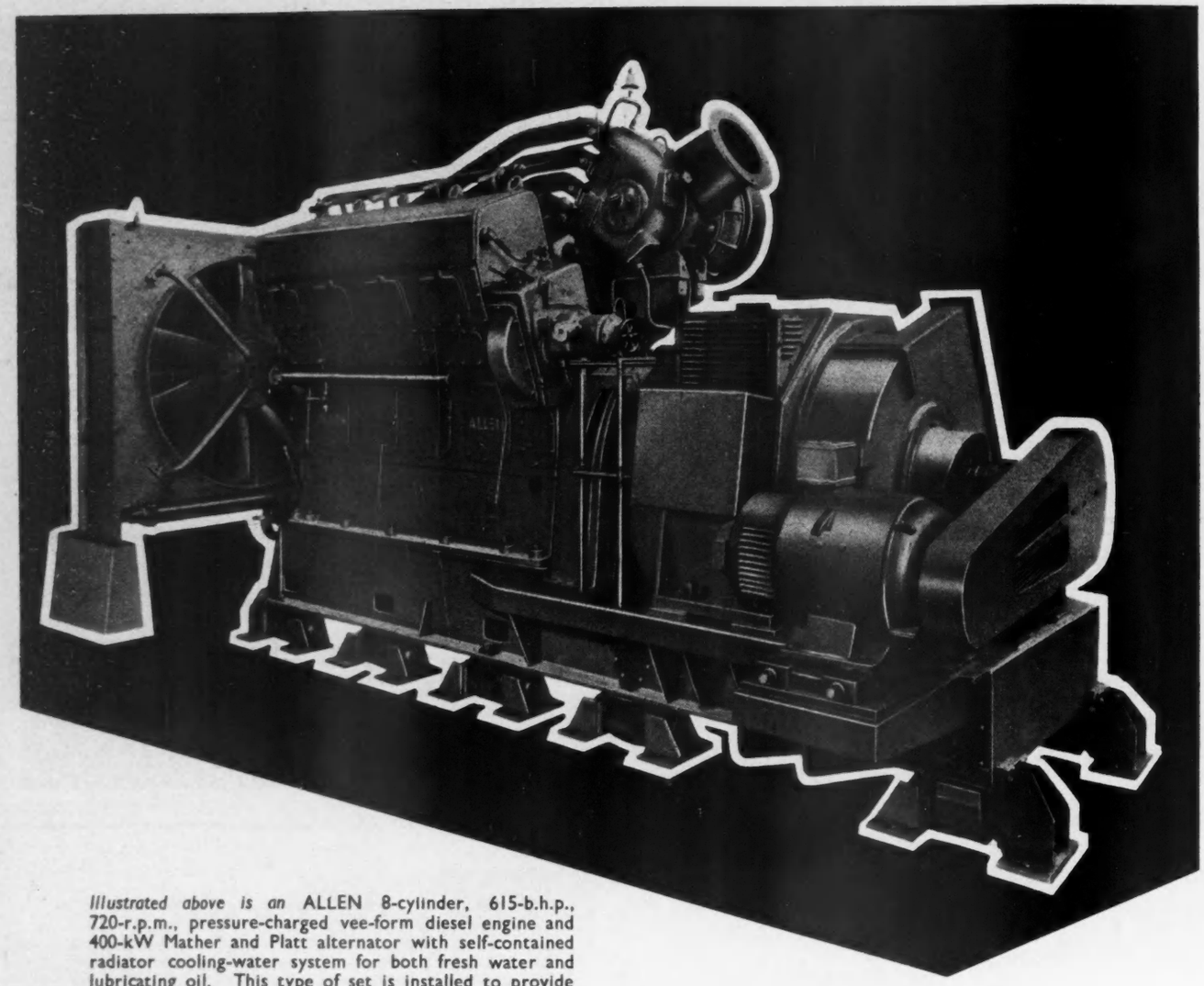

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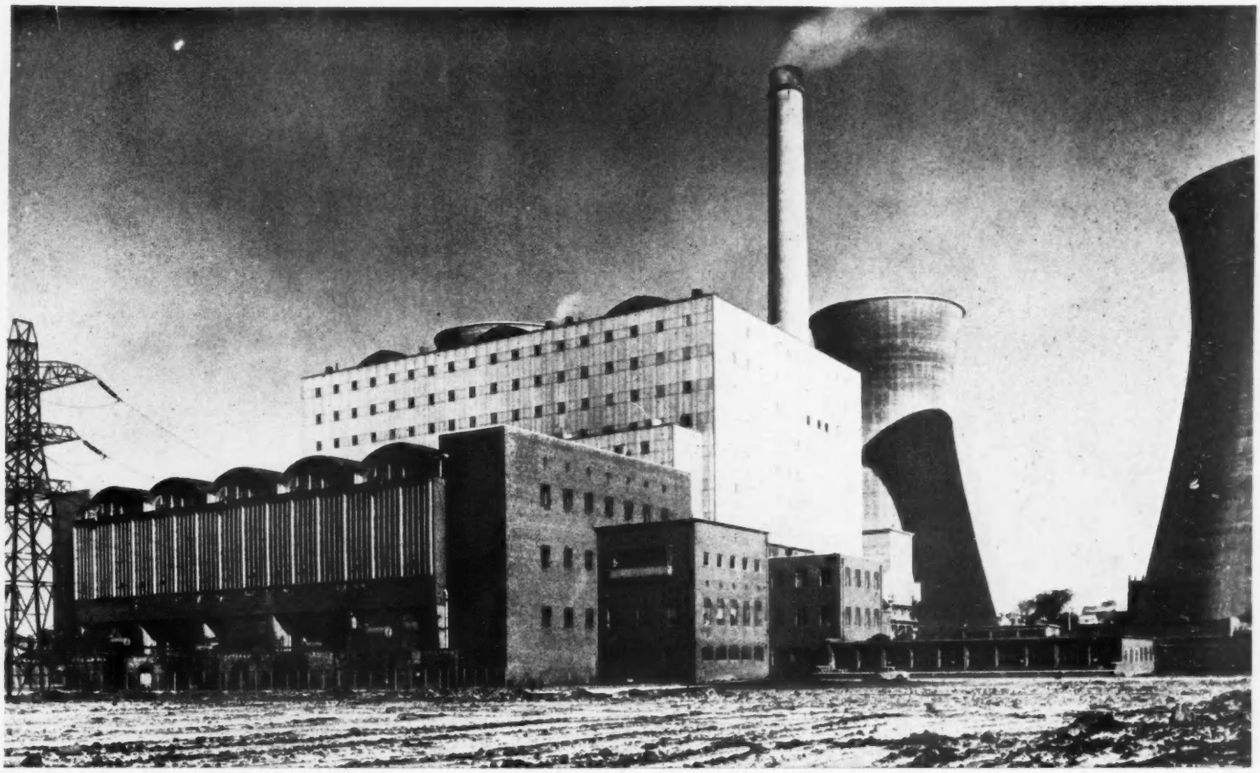

Ferrybridge 'B' power station;
Yorkshire Division, Central Electricity Generating Board.

BABCOCK at *Ferrybridge 'B'*

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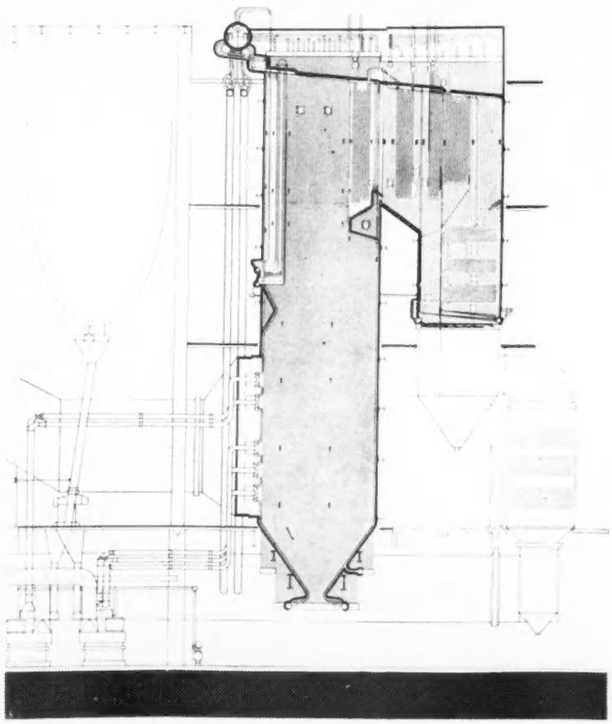

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P/5

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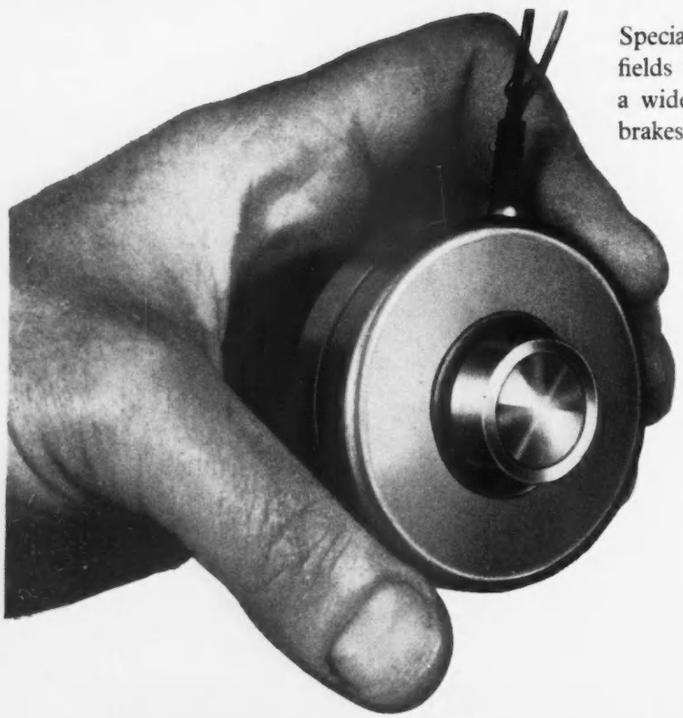

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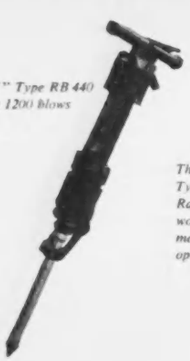

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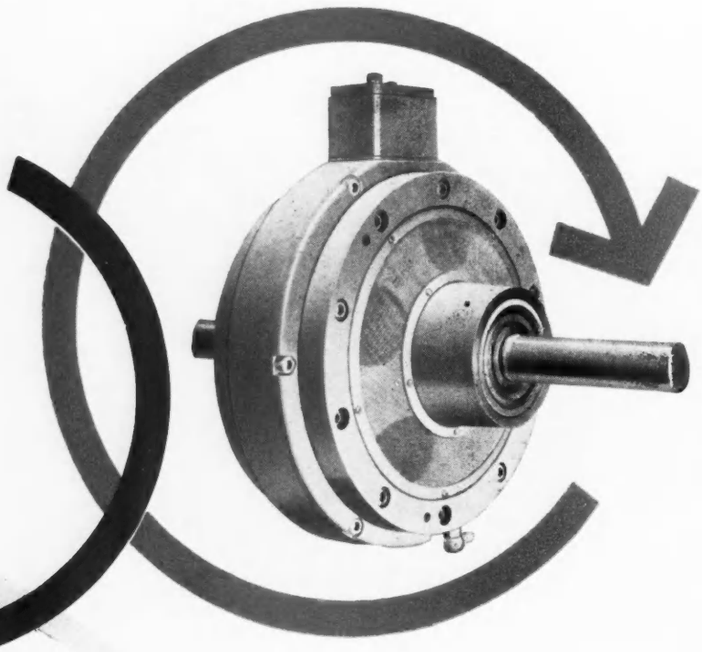
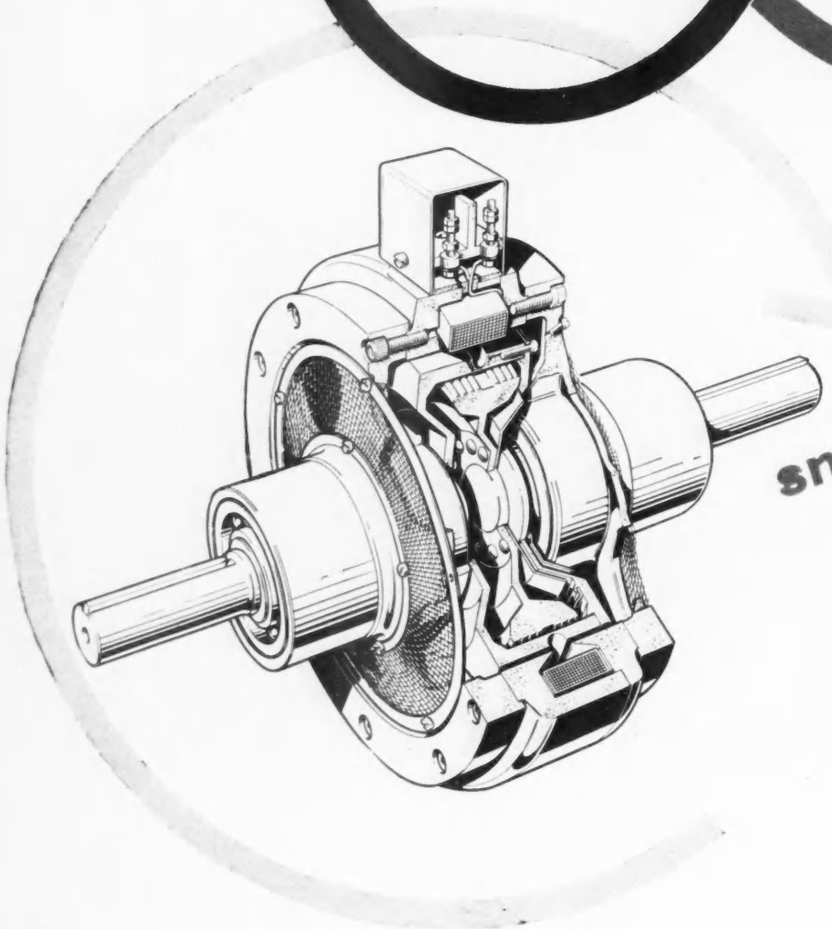
Photograph by courtesy of Messrs. Bernard Sunley and Sons.

SMITHS

Magnetic Particle COUPLING





smooth yet positive

Smooth as a hydraulic coupling, but without the drag, positive as a friction clutch but never needing adjustment for wear, SMITHS magnetic particle COUPLING provides accurate control of torque without complications. It acts as a coupling or brake in either direction and can be remotely controlled from any distance.

If your requirements include coupling units with torque capacities between 1/3 and 200 lb/ft, let us advise you on the application of these units in your plant.

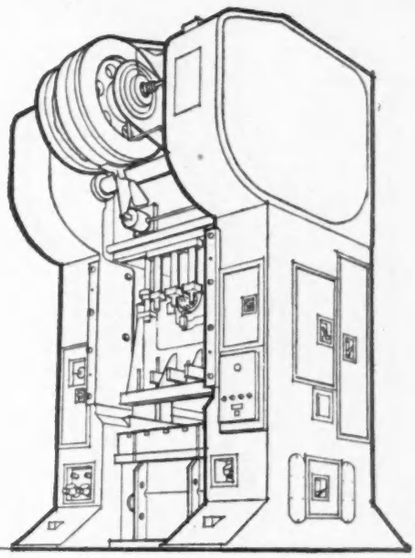
SMITHS

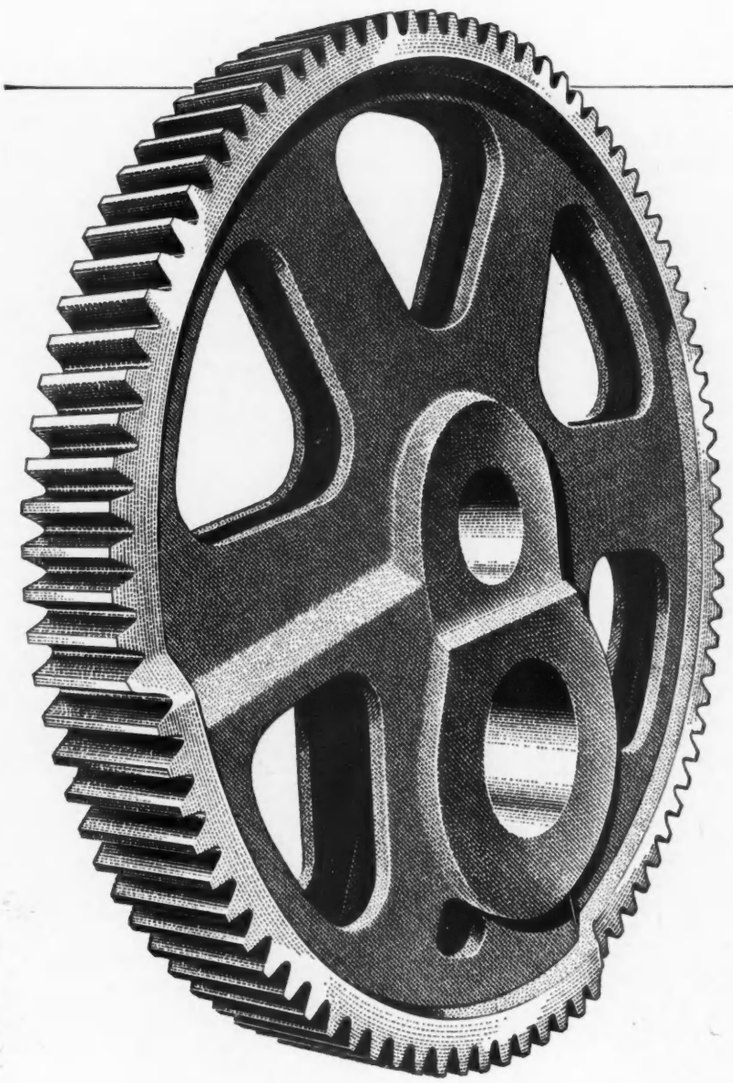
S. SMITH & SONS (ENGLAND) LIMITED

INDUSTRIAL PRODUCTS DEPARTMENT, WITNEY, OXON. Telephone WITNEY 678

4PX

For machinery like this





Castings like this

Eccentric as a gear often has to be, yet of engaging quality. It's a casting with a fine finish. Ready for a hard, working life. Typical of Vickers' high quality steel and iron castings in all grades of BSS 592, BSS 1456, BSS 1760 and BSS 1452.

A good industrial risk — as Insurance men would say. Proof of which is given by radiograph or other non-destructive examination if asked for.

FOR YOUR NEXT PROJECT

Talk over your requirements with Vickers at the planning stage.

Castings by VICKERS

Vickers-Armstrongs (Engineers) Limited

FORGE AND FOUNDRY DEPARTMENT ELSWICK WORKS NEWCASTLE UPON TYNE PHONE NEWCASTLE 33101

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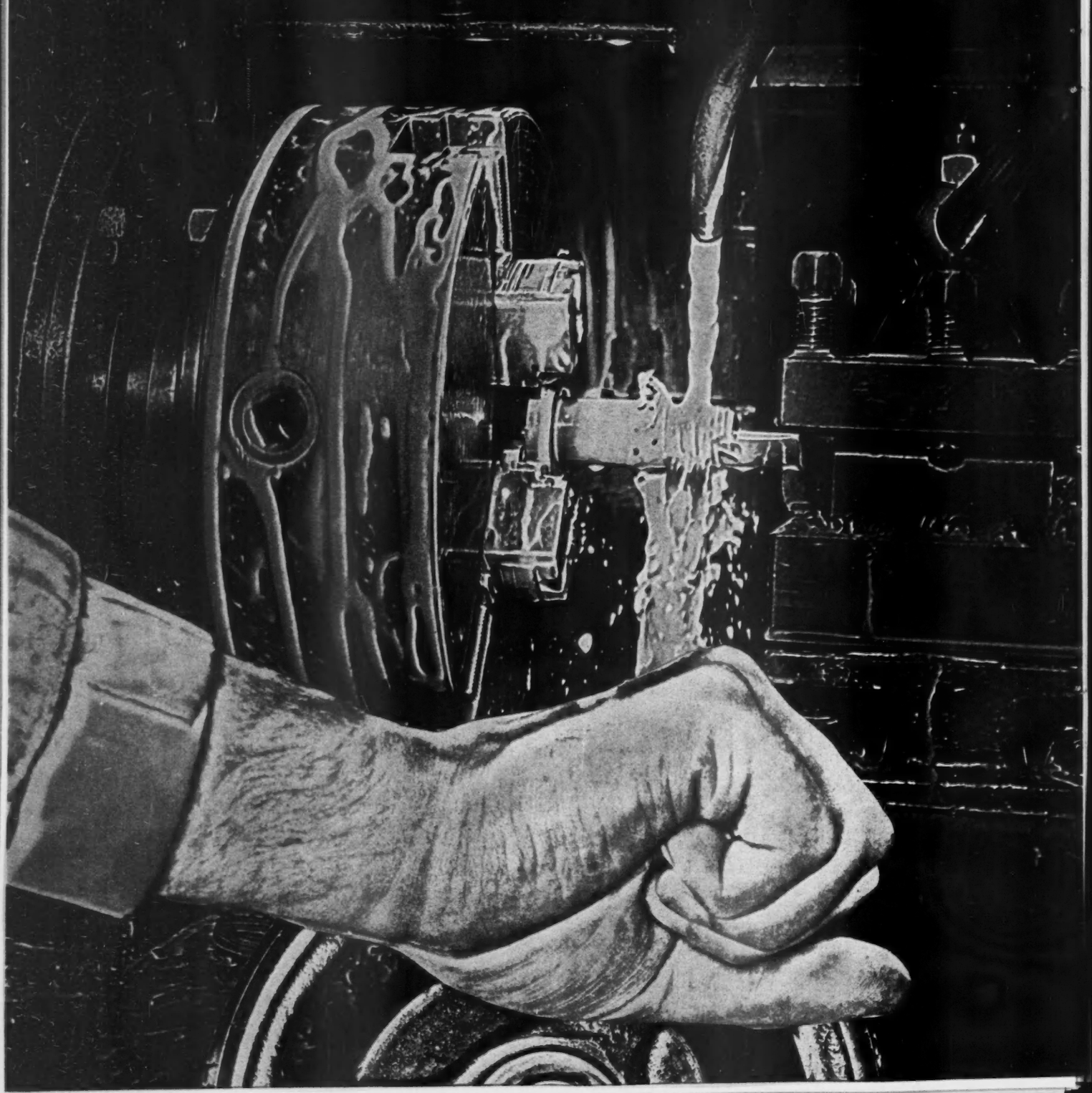
Greater safety for hands



With new Shell Dromus Oils

Most modern soluble cutting oils contain phenolic compounds used as coupling agents between the oil and the emulsifier, for better blending and easier mixing. These phenolic compounds can cause skin irritation, especially where modern high-speed machines are used and the emulsion can concentrate, through the evaporation of water, above the safety level.

Shell research chemists have been working on this problem, which has been causing some concern to Management. After considerable research, Shell Dromus Oils have been reformulated and these new cutting oils now produce bland emulsions, which considerably reduce the risk of skin trouble to operators.

The real difficulty was to find a new coupling agent to replace the phenolic compounds, and Shell finally used what their chemists know as a higher fatty alcohol complex. This solved one problem, but presented another. The new coupling agent was volatile at the high temperatures normally used in blending processes. Further research found a solution to this problem by designing and installing new plant. The new Dromus Oils are every bit as efficient as before and cost no more. They put Management in the welcome position of being able to minimise working hazards at no extra cost. And machine men need no longer be so worried about skin troubles.

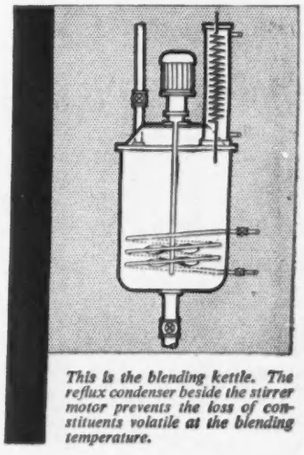
The moral of the story is that Shell research is supremely applicational. The centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right oil for the job. If you and your organisation have any major lubricating problems, it pays to get in touch with your local supplier of Shell Industrial Lubricants.

The Research Story

Shell chemists in the U.K., in Holland and in the U.S.A., prepared and examined hundreds of experimental soluble oils, and established that certain combinations of fatty alcohols could be used in place of phenolic compounds with no loss of efficiency. They set to work to discover the best combination and developed a higher fatty alcohol complex which fitted exactly. Then they realised that to blend this new coupling agent into soluble oils would require special plant and new blending techniques.

Exhaustive testing of blend stability, emulsion stability, anti-corrosion and machining properties led to selection of the most promising blends. A pilot plant was set up to produce batches of these for use in field trials.

This field testing and final development proceeded for two years whilst production plants were erected at points so chosen as to give the most economical and rapid delivery throughout the United Kingdom.

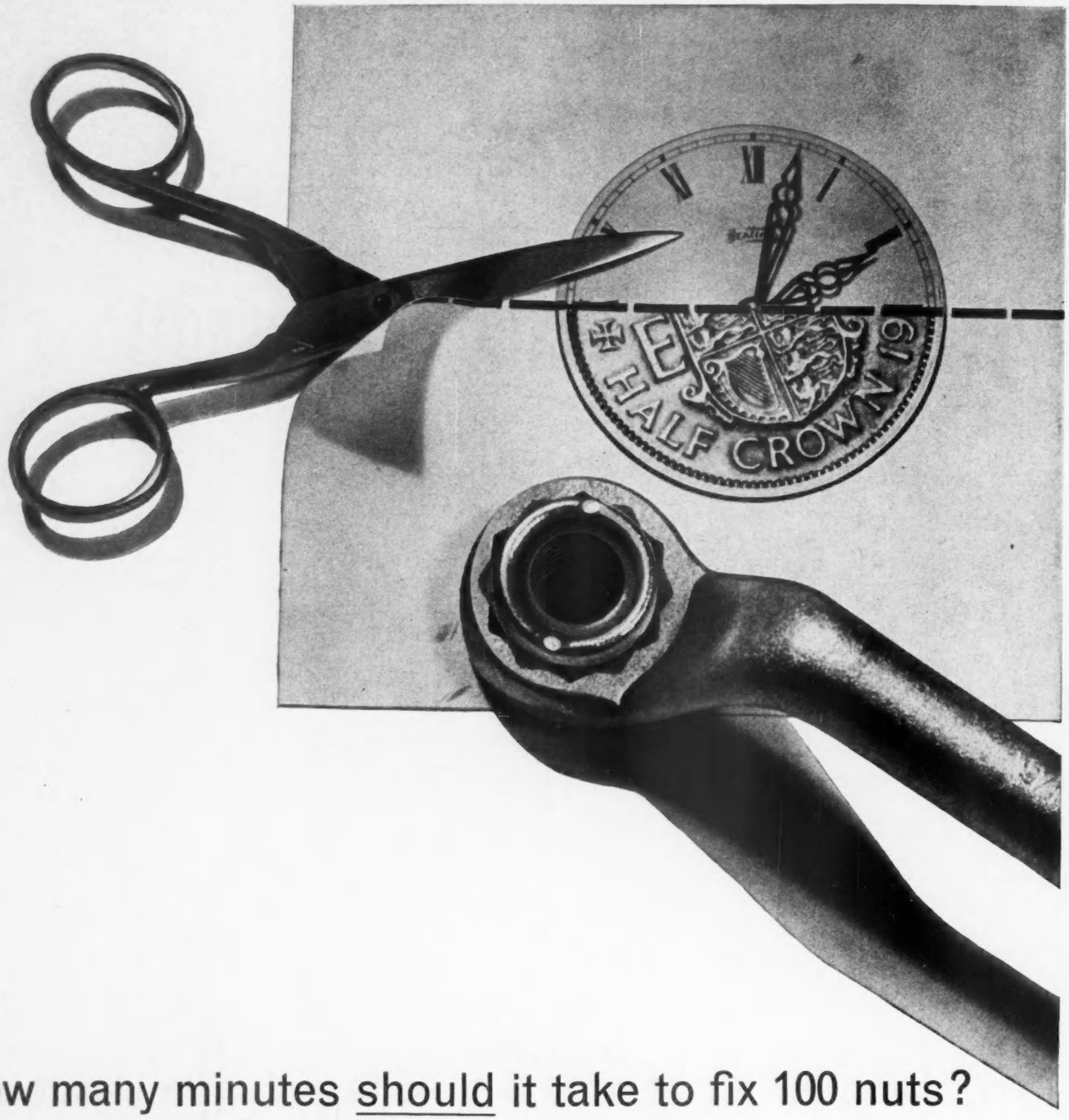


This is the blending kettle. The reflux condenser beside the stirrer motor prevents the loss of constituents volatile at the blending temperature.

NEW SHELL DROMUS SOLUBLE CUTTING OILS

another proof of Shell leadership in lubrication

D2



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* The accepted *time for assembling 100 5/16" slotted nuts and split pins is 197 minutes.
* Yet *need* it take as long? *The job could be finished in exactly 40 minutes using Simmonds self-locking nuts. Forty minutes!* A net saving of over forty shillings on every hundred assemblies, if you reckon wages at 5/- an hour and overheads at 250%.
* Nyloc self-locking nuts save many companies thousands of pounds each year.
* There are also technical and other advantages so why not call in Simmonds to carry out a completely thorough costing of your present assembly methods?

* *All times shown are based on "The Handbook of Standard Time Data for Machine Shops" by Haddon & Genger, published by Thames & Hudson Limited, London.*

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This label is part of what will be a nation-wide scheme, to guide every user of plated products. It means that the plating is carried out to meet the thickness requirements of the new British Standard 1224:59. Because the nickel provides most of the resistance to corrosion, the standard requires minimum thickness of the metal for various conditions of service. The labels are coloured Green, Blue and Red, to indicate the three gradings of the British Standard.

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It will pay you to display the label of plating quality on your goods. Send for a copy of our booklet "Confidence in Plating" which describes the scheme in detail and explains how you can join. The use of these labels on good quality plate will add extra confidence in the quality of your products.

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TGA MC4

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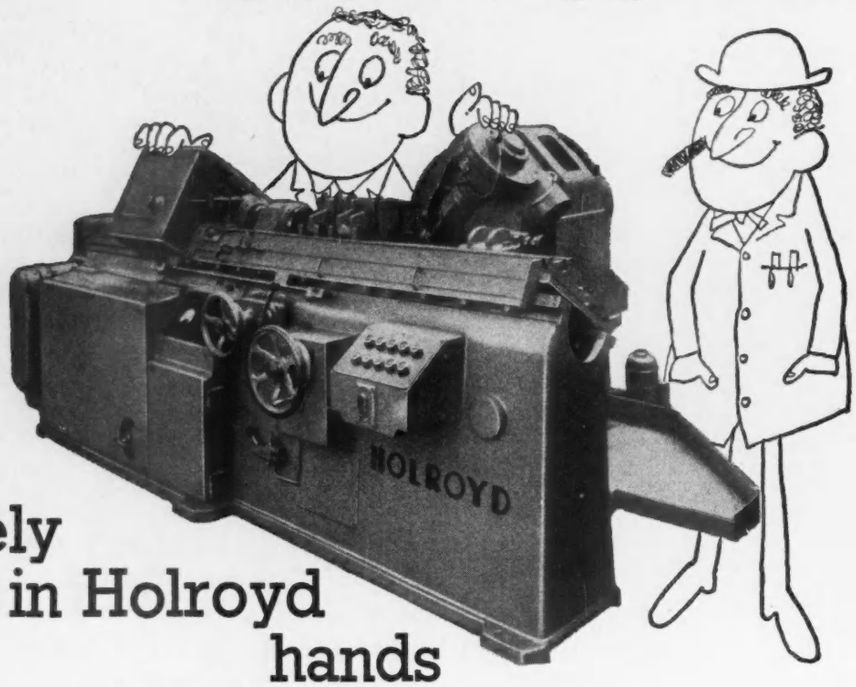

safely in Holroyd hands

If you have a big call on rotors it is worth remembering that our Rotor Manufacturing Section is completely equipped with unique machines of our own design and manufacture and that we now have a long experience in this very specialised field which might be of invaluable use to you. Our pioneer work in rotor manufacture has cleared the way for their increasing use with compressors, pumps, blowers and meters, and we can make them accurately to your design, either complete or from your prepared blanks.

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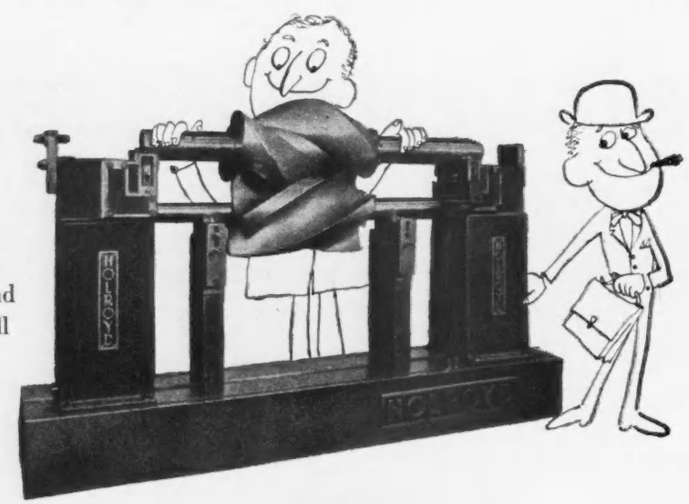
SMALL ROTORS

The biggest Holroyd machine can make rotors up to 32″ diameter and 50″ face. The smallest machine will go down to 1″. Helix angles can be anywhere between 30 and 60 degrees, with any combination in the number of lobes.



Holroyd

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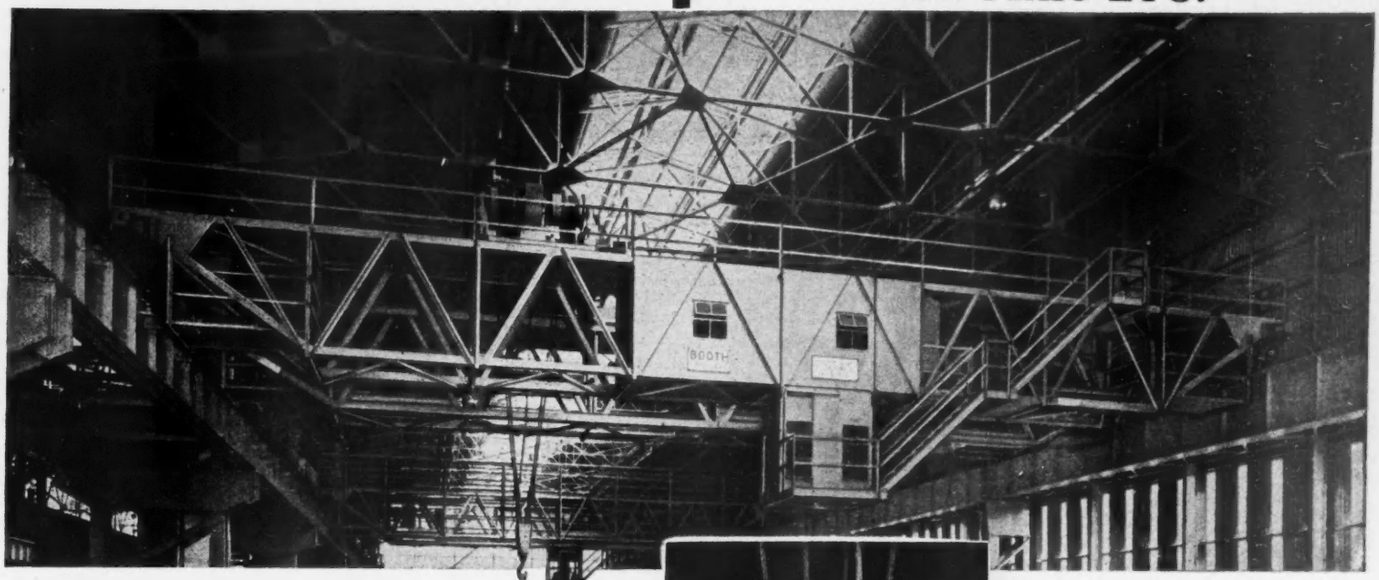
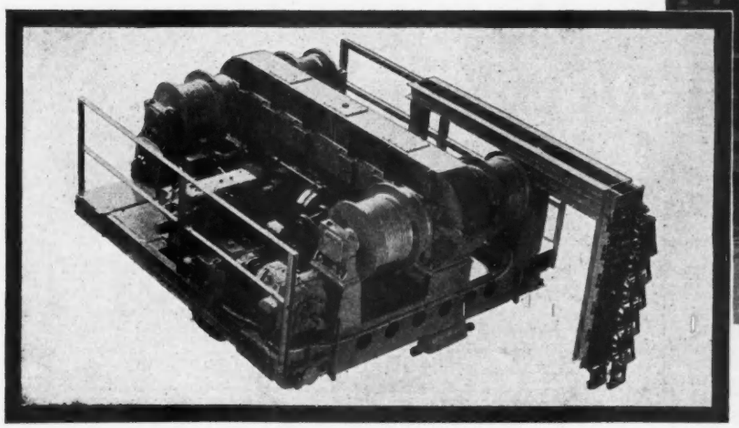
CRC 43

CLYDE-BOOTH

CONTINUOUS PROCESS CRANES FOR STEELWORKS ETC.



(ABOVE) Clyde-Booth four point suspension electric overhead travelling magnet crane at Messrs. Colvilles Ltd., Ravenscraig Works.
(RIGHT) The hook with slip-ring gear for the magnet, showing attachment of the four ropes.
(BELOW) The special four barrel crab.



With the introduction of higher rates of acceleraton and braking on traversing and long travel motions, in order to get the maximum output from overhead travelling cranes, magnet cranes with multiple splayed ropes are finding favour.

This type of suspension effectively damps out swinging of the load due to acceleration and braking forces.

Clyde-Booth cranes of three and four rope suspension design are produced to meet these requirements.

Please ask for information on our range of cranes.

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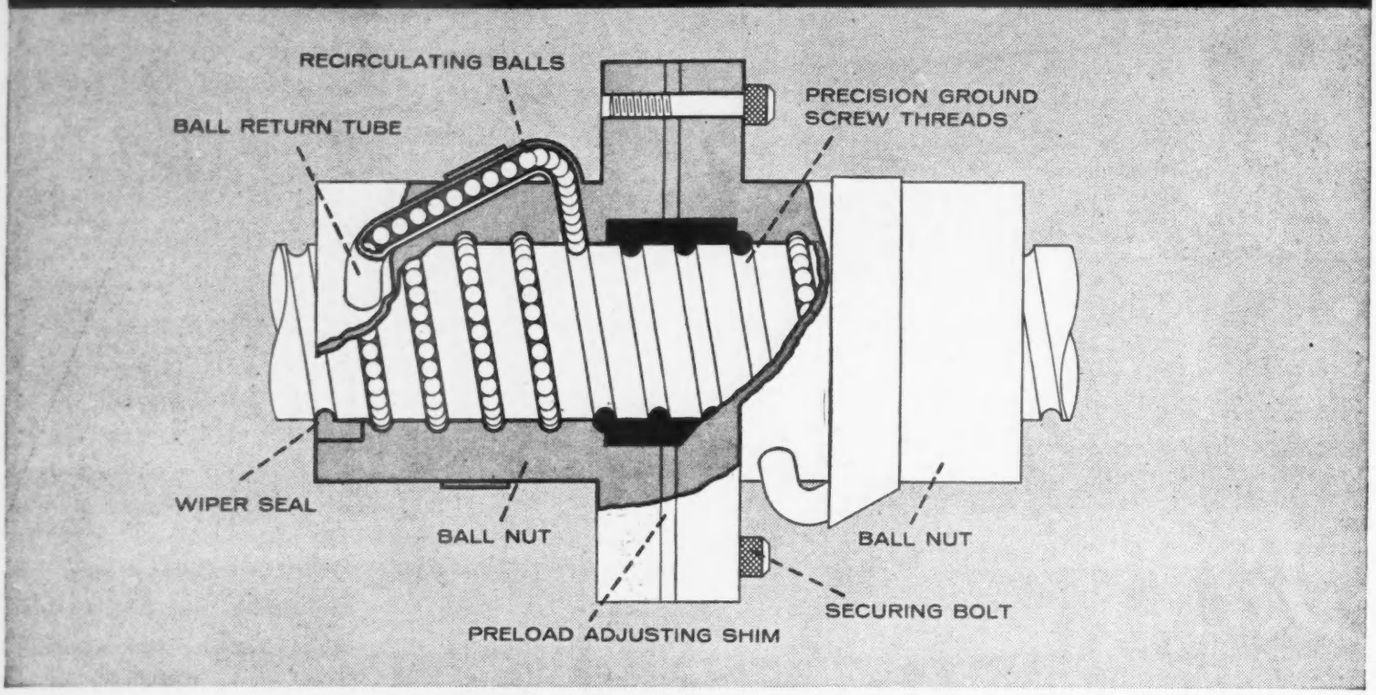
Beaver pre-loaded ball screws, up to 95% efficient, operate at -52°C to over 400°C with no backlash...



...ANOTHER ENGINEERING ADVANCE FROM BRISTOL SIDDELEY

Bristol Siddeley Engines Limited produce Beaver* pre-loaded ball screws. These ball screws achieve a minimum efficiency of 90% and they can operate within a temperature range of —52° C to 400° C without lubrication, and up to 170° C when lubricated.

Machined and ground to the highest standards of precision engineering Beaver pre-loaded ball screws greatly increase transmission efficiency. They reduce the power required for actuation by as much as 80%, when converting rotary drive into linear output or force input into torque output. By eliminating backlash, with pre-loading, they give precise control over very small increments of motion and a high response frequency. And when compared to conventional screw mechanisms, they provide a predictable operating life which is much longer, require much less maintenance and give more trouble-free operation.

Basic design application analysis

Bristol Siddeley engineers make an exhaustive analysis of each specification. And each unit is specially designed for its particular application. Beaver ball screws are made automatically reversible or with controlled "no-back," with multiple or single circuits. Beaver pre-loaded ball screws have been proved as the most efficient method of converting rotary into linear thrust in over 2,700 engineering applications in many branches of industry. They have been designed already with rated operating load capacities of 370,000 lb (825,000 lb maximum static load) but the maximum potential operating load is, in most cases, limited only by the requirement.

Bristol Siddeley Beaver ball splines have been developed to eliminate the disadvantages of conventional splines. The designs are very effective in minimising friction, particularly when high torsional and bending loads are imposed during linear movement.

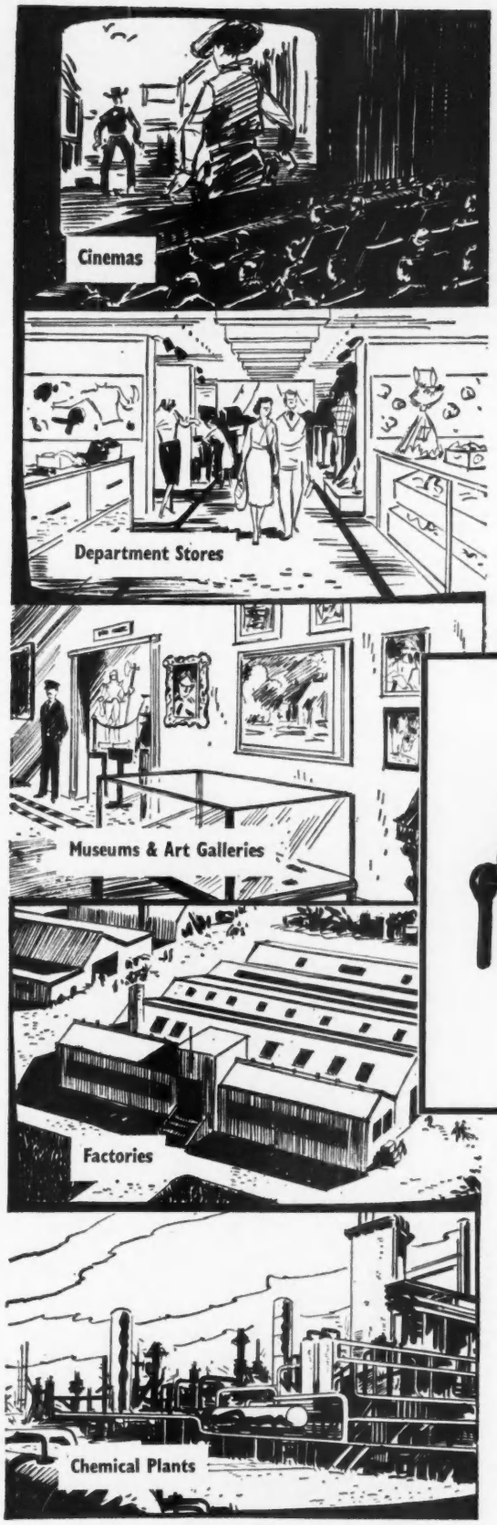
* *Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

For further information please write to:

J. B. STARKY, SALES MANAGER (BEAVER PRODUCTS DIVISION), BRISTOL SIDDELEY ENGINES LIMITED, PO BOX 17, COVENTRY, ENGLAND.

BRISTOL SIDDELEY ENGINES LIMITED

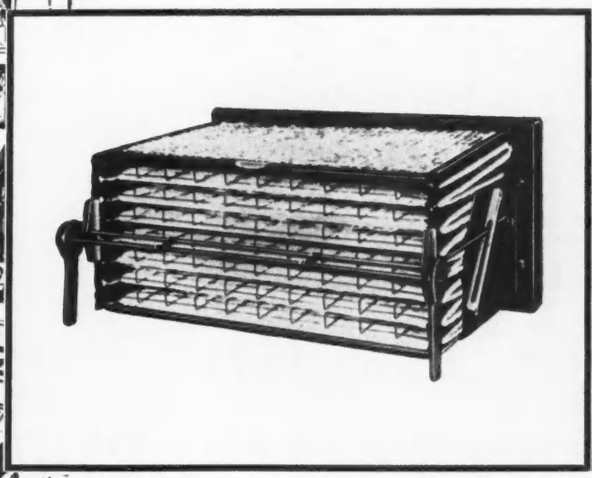
TRUST* K.600 KOMPAKS to clear the air

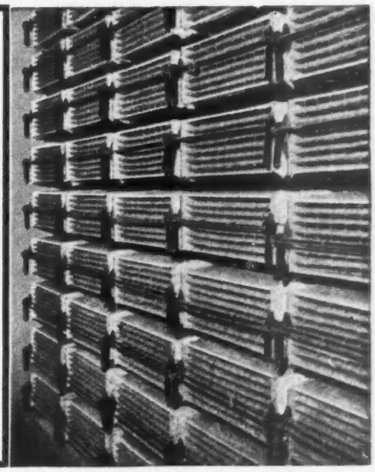


Perfected by years of research and development in the Vokes laboratories and in the field, the K.600 'Kompak' air conditioning filter is the most efficient as well as the most widely used of its type. Features which have led to its popularity include long life, reliability and extreme ease of maintenance.

Efficient air conditioning filters are essential in the provision of clean air inside buildings of all kinds. Impurities in the air supplied to factories can cause contamination of products or damage to valuable plant; in public buildings unfiltered air shortens the life of furnishings and decorations. Vokes K.600 'Kompaks' are installed in the air conditioning systems of large commercial and industrial office blocks, factories and engine test houses, public libraries and picture galleries, hotels and cinemas, concert halls, hospitals, multiple stores and establishments for scientific, pharmaceutical and photographic research and processing.

*** You can trust the K.600 'Kompak' because like all Vokes air filters it is fully tested in accordance with BSS.2831.**





Simply constructed and using an inexpensive, easily replaced filter medium, the K.600 'Kompak' has a normal rating of 600 cubic feet per minute with an initial resistance of 0.15 inches w.g. The actual velocity of the air passing through the developed area of the filter is only 22.5 feet per minute. Tested in accordance with BSS.2831, using highly penetrating test dusts, the 'Kompak' recorded an efficiency of 95% against Aloxite 50, and 93% against Aloxite 225.

The K.600 'Kompak' is ideal for general air conditioning, general ventilation and industrial air cleaning, particularly in areas where a sooty atmosphere prevails. It can also be supplied in flameproof and tropicalized versions, and a special super-efficiency type is available in which a layer of glass-wool backing the standard filter medium extends performance down to sub-micronic particles.

'KOMPAKS' FOR KELVINATOR

Kelvinator (Australia), who manufacture refrigerators for domestic and industrial purposes, use K.600 'Kompaks' as a second stage filter in their paint shop. The standard of paint finish acceptable is extremely high and efficient filtration of the dusty air is essential, particularly as the high gloss paint used accentuates any dirt defects. Since their installation the two banks of seventy filters each have given complete satisfaction, one bank having been in operation for two years without replacement of the filter medium. The intake (dirty) side of one bank is shown in the photograph above.

Write now for comprehensive literature on the 'Kompak' and Vokes' other air filters.

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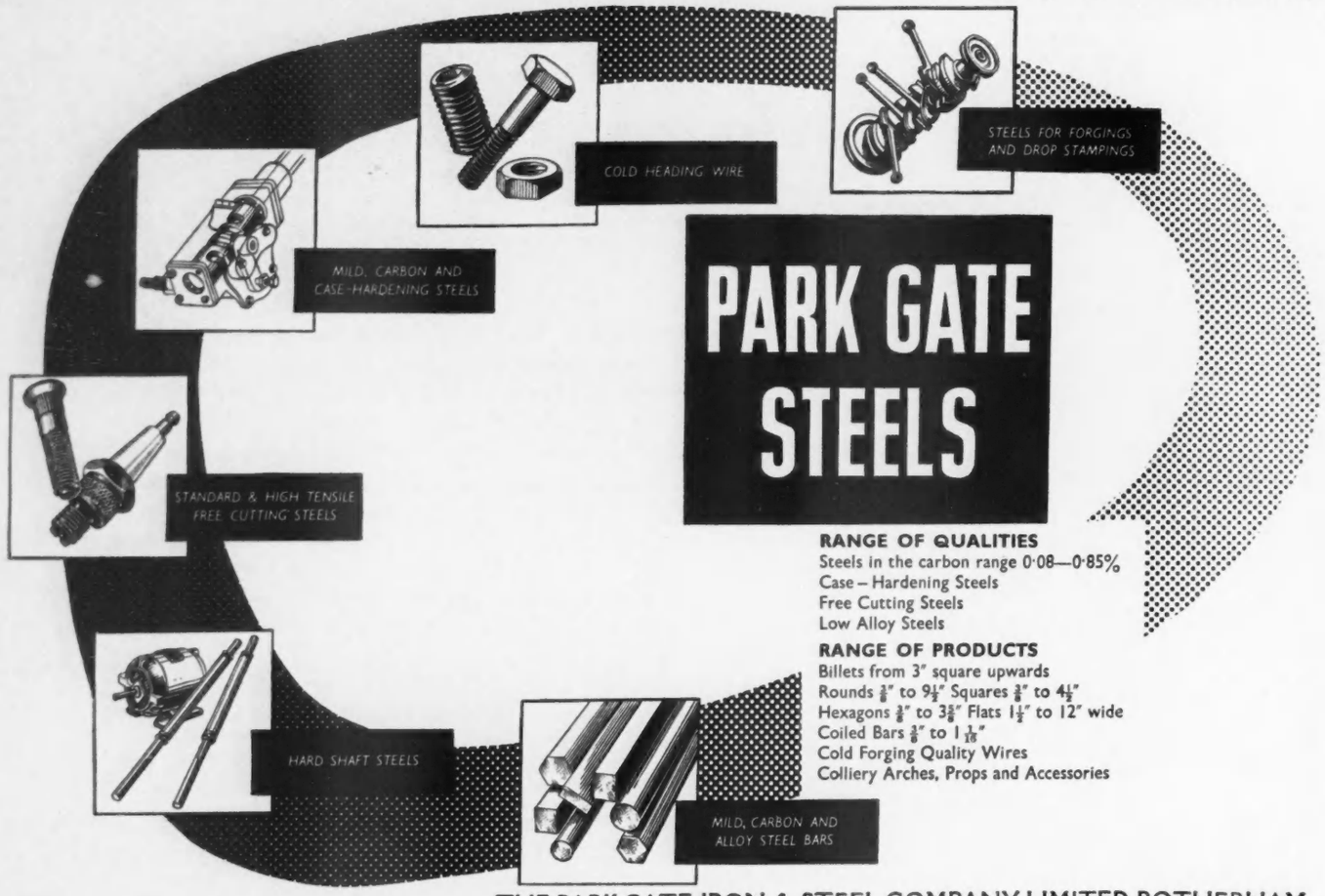
Vokes Australia Pty. Ltd., Sydney.

Represented throughout the world

V525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Billets from 3" square upwards
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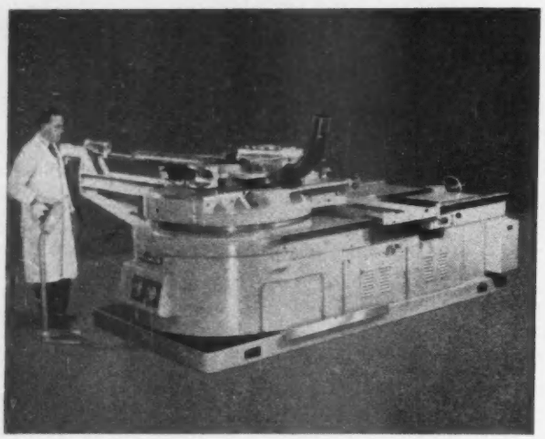
TUBE BENDING MACHINERY

★ Heavy duty motorised Mandrel Bender, Type MSA6, with robust all mechanical drive.
★ Produces full bore bends, free from wrinkling, cold and unfilled on standard or short radii.



★ Easily set up for both left-hand and right-hand bending.
★ Variable speed gear-box provides correct bending speed according to size and class of tube.
★ Bends up to 6¼in. dia. mild and stainless steel tube, 6in. bore gas, steam and hydraulic tube and 8¼in. dia. non-ferrous tube.

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These characteristics of DEE M.A.G.'R' enable you to solve many problems of high temperature lubrication inexpensively and simply—problems such as lubrication of boiler head gears, bearings on trolleys entering hot steam chambers, charging ladles in steel works.
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N.B. For lubrication at temperatures up to 1000°F specify DEE 633 Refractory Lubricant.

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Delta Works, Irlam Road, Bootle, Liverpool 20
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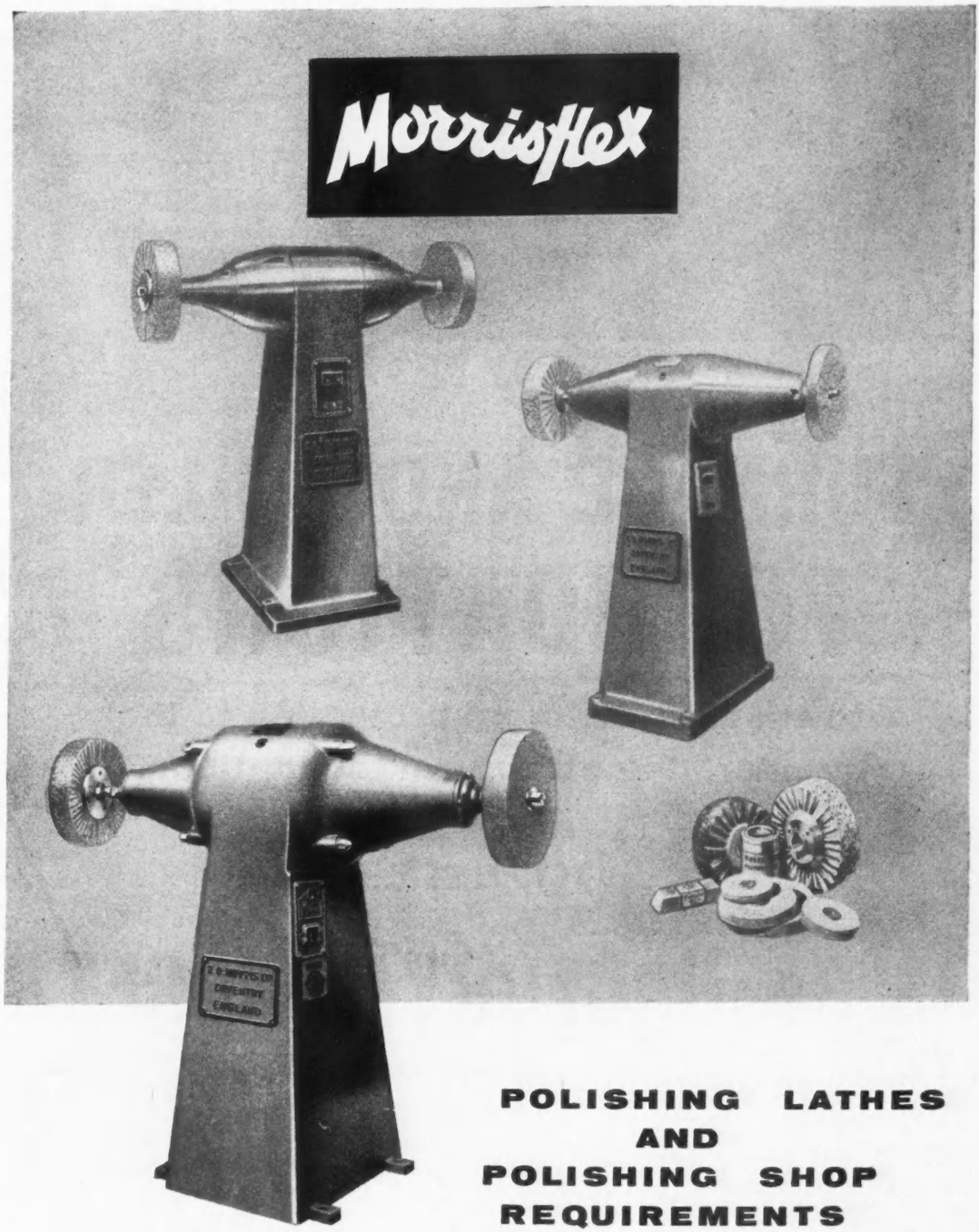

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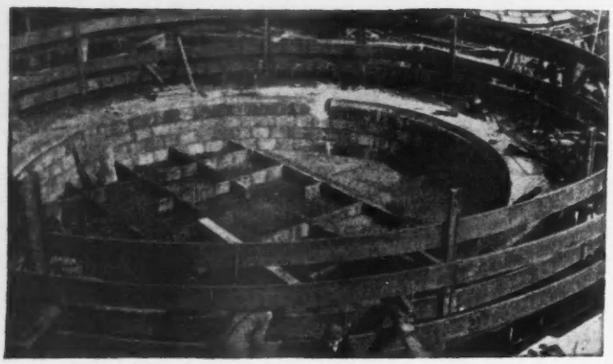

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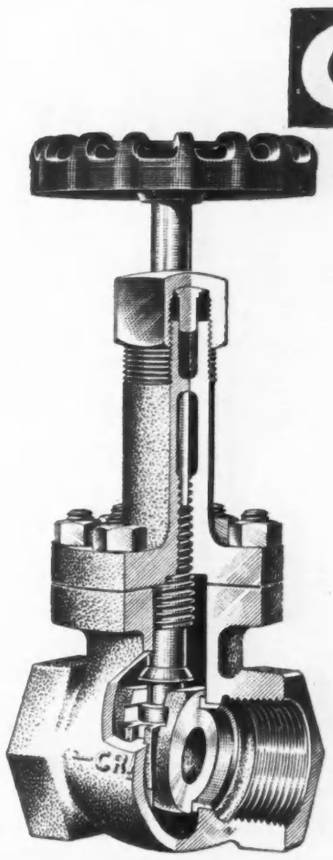
BULLETIN ON CRANE NICKEL ALLOY WEDGE DISC BRONZE GATE VALVES

...featuring the D186—with stainless steel seats.

This high pressure Bronze Valve is designed to take steam pressures up to 300 pounds (temperatures up to 550° F) as well as water, oil or gas, cold, non-shock services up to 1,000 pounds. The body and bonnet are cast from high grade bronze and the Nickel Alloy solid wedge disc and stainless steel seats are especially resistant to wear. Back-seating allows the valve to be repacked while fully open under pressure.

Hexagon ends with British Standard taper threads or to American Standards. Non-heat handwheel; Rising Stem. Sizes ¼" to 2". Sizes ¼" to 1" have a union bonnet.



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V.10

Lubricants for brake linings . . . ?
No, not really. But manufacturers of bearings made from resin-bonded asbestos — commonly used for brake linings — do incorporate "dag"* colloidal graphite in their products. Why? Because the fineness and stability of the particles in any Acheson dispersion ensure that the inherent properties of graphite are imparted to the material. Acheson dispersions may be impregnated or incorporated into fibres, leather, cloth, wood, paper and many other substances. "dag" colloidal graphite is heat-resisting, chemically inert, friction and therefore wear-reducing, electrically conducting and an excellent "parting" agent.
These are the reasons why it is used extensively in industry as an integral part of, for instance, non-metallic bearings, packings, conducting textile tapes and braids, resistance heating panels of many types. If the possibilities interest you, write to the first and foremost manufacturers of colloidal graphite for specific recommendations.

lubricants for brake linings ?

Acheson Colloids LIMITED
subsidiary of Acheson Industries (Europe) Limited

50 YEARS

* *Registered trade mark of Acheson Industries (Europe) Limited; licensed user - Acheson Colloids Limited.*

ACHESON

"dag" colloidal graphite is incorporated in the asbestos-type bearings manufactured at the High Wycombe Works of Railko Limited. One stage of production is illustrated.

P.O. BOX 12 · PRINCE ROCK · PLYMOUTH · DEVON Also ACHESON COLLOIDS CO., PORT HURON, MICHIGAN, U.S.A. & ACHESON COLLOIDEN N.V. SCHMEEDA (GR) NETHERLANDS

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WITHSTANDS CLIMATIC EXTREMES
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The seven ages of a £14 million steel project

A picture history of Consett's new 4-high Plate Mill

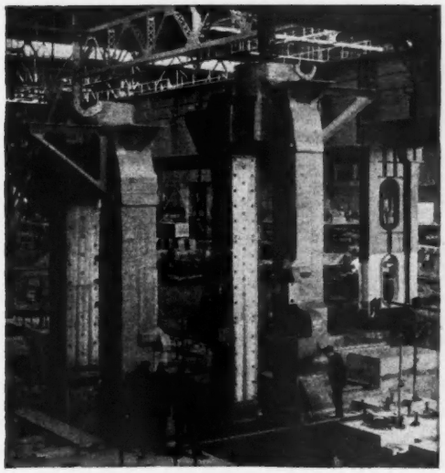
NOVEMBER '58. The site is cleared. In May '58 work began on levelling an enormous platform, over half-a-mile long, in the hillside at Hownsgill. A waste-heap on the site was still burning in places.

MAY '59. The first column went up on May 4th, 1959. Two million cubic yards of earth had been moved, about 7 miles of new railway track had to be laid, two bridges constructed.

JULY '59. The skeleton rises. 600 men were now at work on the site, and the framework of the mill was well under way. Altogether 11,500 tons of structural steel were to be needed.

SEPTEMBER '59. Foundations for the mill's equipment were meanwhile being excavated. For the mill stand five huge columns were driven down 50 ft. Hole here is for cross-cut shear foundations.

DECEMBER '59. Equipment for the mill was now starting to arrive. Some of the roof was on, and they were installing the overhead cranes—one of them big enough to lift 150 tons.



MAY '60. Installing equipment. The first job for the overhead cranes was to install the equipment of the mill. Here the housing for the great mill rolls is being manoeuvred into position.

JULY '60. Finishing touches. By now the mill stand, the great shears (capable of cutting nearly 2″ thickness of steel) and the cooling banks were all finished.

The next stage of development

When it is finished, the Hownsgill mill will be able to produce 10,000 tons a week of the highest quality steel plate in the world—plate for ships and boilers, rolling stock and machinery.

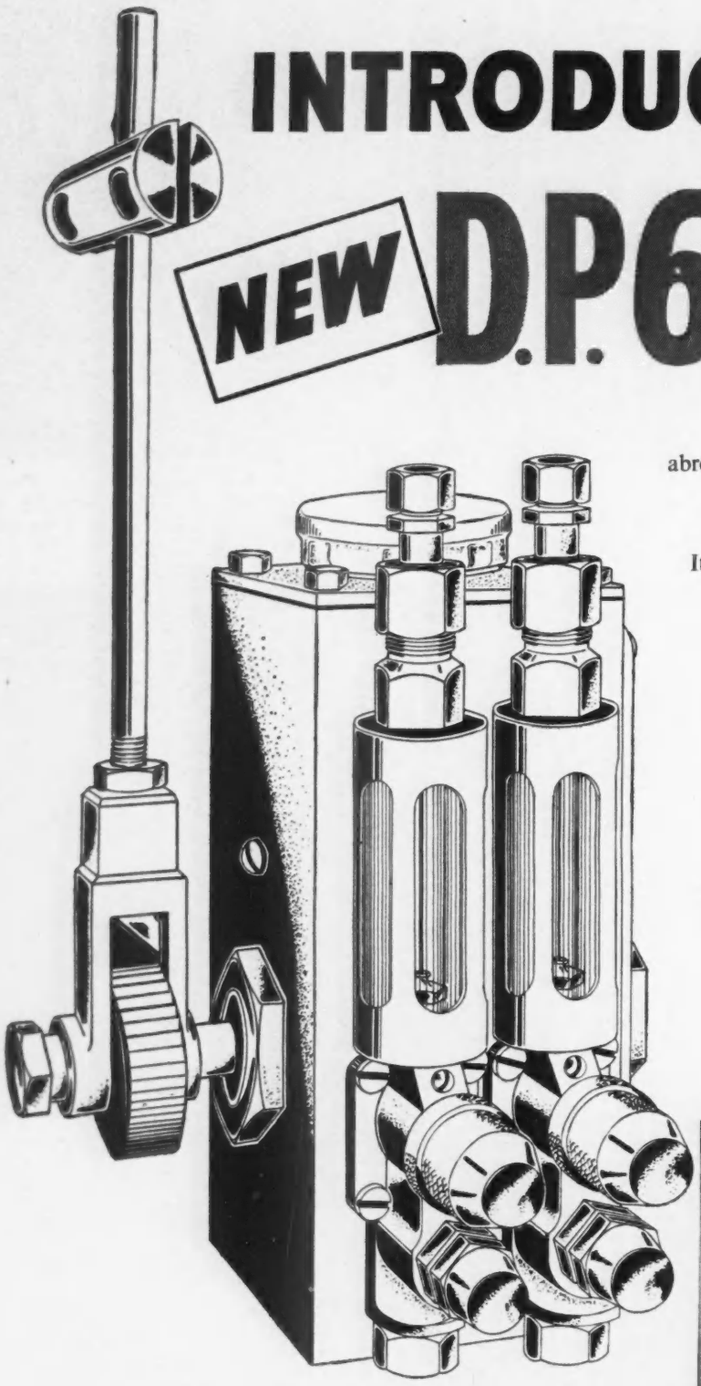
But Consett's development plans will not stop there. The next stage is the introduction of the revolutionary 'oxygen' process for steel making. Two new types of converter are to be installed, using jets of oxygen to refine molten iron more quickly and reliably.

Looking further ahead, the plan includes a new blast furnace of 28-ft. diameter, new coke ovens and gasholder and a new ore yard. The whole cost will be very nearly £30 million.

CONSETT
IRON COMPANY LIMITED

CONSETT, COUNTY DURHAM · TELEPHONE: CONSETT 341 (12 LINES) · TELEGRAMS: "STEEL PHONE CONSETT"

INTRODUCING THE NEW D.P.60 MECHANICAL LUBRICATOR



During the last 60 years, Wakefield lubricators have kept abreast of the changing needs of industry. The DP 60 represents the experience of these years. It is an instrument of precision for feeding oil against pressures up to 1000 p.s.i. It can be operated by the plant it lubricates on reciprocating or rotating drive. The flow of oil is automatically controlled by the 'start-up and cut-off' of the machine. Efficient lubrication is combined with economy in oil consumption.

ADVANTAGES OF THE DP 60

Welded steel construction gives strength with low weight ratio.

Each feed can be regulated independently.

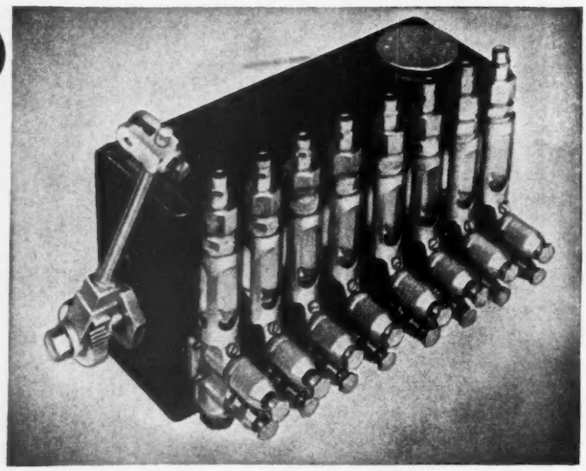
Complete pump unit can be removed and replaced in one assembly.

Patented quick release cap minimises oil contamination.

Up to 32 feeds can be fitted.

Large oil reservoir ensures long working periods between topping-up times.

Built-in perspex oil gauge on the oil reservoir.



WAKEFIELD
INDUSTRIAL LUBRICATORS

Ask for our DP 60 booklet. Send us the coupon and we shall be pleased to mail you a copy with full DP 60 details — by return of post.

PLEASE SEND ME A COMPLIMENTARY COPY OF THE DP 60 BOOKLET

To: Dept. P. D. Wakefield-Dick Industrial Oils Ltd., Castrol House, Marylebone Road, London, N.W.1.

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EG

ENGINEERING Impact

of Declining Exports and Rising World Trade

IT IS not a question of doing something completely new, of using untried methods. Raising the United Kingdom's level of exports, said the Prime Minister at the start of the week, is just a matter of making the little extra effort.

The objectives recalled by Mr. Macmillan were familiar enough. To pay our way, to eat well, to give our children the fullest possible education, to earn enough in order to invest in our own industries, and to produce a surplus with which to invest abroad and assist the developing nations.

Mr. Macmillan suggested that the answer does not lay only with the big firms. There are many engineering firms actively supplying the exporting companies. Might they not get out on their own account and sell directly in the export markets, gaining experience, money—and even joy?

The Germans, have devised a word for the joy of exporting, it is *Exportfreudigkeit*. This comes, or so the Prime Minister thought, to the man trading successfully abroad, from the new techniques, new ideas, new designs which he acquires, or which are forced upon him, in his foreign activities.

And it is in this that the answer to the present plight of UK trade may be found. Trade fairs, Government publicity, advertising campaigns are all very necessary but, like a signpost, they can only show the way, they cannot do the travelling for you.

And this is where every sort of engineer comes in. Lengthening delivery dates are poison to foreign trade when production from German, French, Czechoslovakian, Japanese factories is climbing all the time.

Even with the home demand in the United Kingdom kept in check the production man who can get the Prime Minister's "little bit extra" out of the plant is contributing just as surely as the man who comes up with the new idea.

And new designs, new accommodation of our productive ability to the needs of the Swedes, the Ghanaians, the Brazilians is essential if the UK is to have a rising and not a sinking share in world trade. The American car makers riposted to our attack on their markets with a successful parry, the compact car. We have to be nimble witted enough to produce a counter-thrust, and so on through all our trade.

Shipbuilders Revitalised

A wind of change will blow through the engineering industries if the shipbuilders go in for hovercraft on a large scale.

Among the likely changes; a pronounced shift of research scientists and engineers into the shipbuilding industry, probably drawn mainly from the aircraft industry. With the research staffs will come other scientific types whose experience and expertise are in design, production and the contemporary tools of management, such as operational research and automatic data processing.

In such a traditional industry as shipbuilding, the effect on foremen, charge hands and shop-floor workers will be stimulating and disturbing. In a static industry, it might cause unpleasant repercussions, but expansion and prosperity should warm the heart of a revitalised industry and help men to forget old differences.

In technical advances the shipbuilding industry has been overshadowed by other industries in recent years. But not many engineering industries have such a lively history of technical progress, and now a new sweep forward seems imminent.

The industry shows signs of grasping the opportunity. There is a less obvious but equally important, opportunity hovering over those firms in other industries who will be the suppliers and servicers of the strange new yards.

50 Miles An Hour Under the Channel

There is an odd move just now in Parliament to push the Channel tunnel idea on a bit.

Something of what a Channel tunnel would in practice involve has been set out by Professor Gilbert Walker, Professor of Commerce at Birmingham University, in a recent article. His main argument against a channel rail tunnel is on the uneconomic nature of trans-shipping a cargo for a rail journey of about 35 minutes.

This extends far back from any potential railhead in Kent or the Pas de Calais. Given a road bridge, the products of a Midland factory would be fed from the despatch department to a lorry, carried without any further handling to their European customer and there unloaded.

The minimum that a rail tunnel would involve would be some form of road transport from the works to a local station, loading for rail carriage, perhaps reforming of the train for the journey under the Channel and then again for the journey through Europe to another local station and unloading for another road journey to the customer.

All of this would be overcome by a road tunnel, but predictions based on passing 1,300 vehicles an hour through 11 ft wide traffic lanes suggest to Professor Walker a speed of 52 miles an hour, bearing in mind ventilation limitations.

Developments in automobile engineering have immensely increased the strain on the driver, but nothing like this has yet been imposed and the prospects of what could follow from a single error or serious mechanical breakdown are grim indeed.

The answer to all these doubts, and to accommodating all the extra traffic of trade and tourism generated by the increase in Anglo-European activity, which is the objective, is a bridge. Without problems of ventilation or transhipment, a road and rail bridge of cross-Channel dimensions has one further immense advantage.

The demand for bridges in the world far outstrips that for tunnels. The creation of a Channel bridge would be a splendid advertisement for British engineers, British steelmakers and of a still forwards moving spirit.

There is hope yet. Mr. W. Proudfoot, the Conservative member for Cleveland, has put down an amendment to the motion in the Commons. It is simply to replace each reference to a tunnel with the word "bridge".

of the Need for Speed in the Aircraft Industry

It is now possible to survey the broad outline of the work programme which will be keeping the airframe groups of the United Kingdom busy for some way ahead.

The British Aircraft Corporation, made up of the Vickers-Armstrongs (Aircraft)—English Electric Aviation—Bristol Aircraft—Hunting Aircraft, is now assured of Government support for the VC 10 and for the more advanced Super VC 10. Two years ago, the British Overseas Airways Corporation contracted to buy 35 VC 10s, at a cost of £60 million. Last month the Corporation agreed to buy 10 Super VC 10s for about £25 million. The Super VC 10 is primarily a plane for the lucrative North Atlantic trade.

Mr. Sandys announcement is of real value to the two big groups. It strengthens their hands in preparing for the sharp end of the battle; that of selling enough of these extremely expensive transport units overseas and so making the operation profitable.

For Hawker Siddeley, with de Havillands, A. V. Roe, and Armstrong Whitworth on its air side, the Minister's statement applies to the DH 121, the first of which is being built, and to the turbo-prop civil and military transport the Armstrong Whitworth Argosy.

What is now the urgent requirement? It is primarily speed. The American, the French, the Russian aircraft industries are not asleep. It was the French who put the engines at the rear of the Caravelle.

De Havillands are in a very strong position with their 121. With a normal high cruising speed of over 600 m.p.h., it has a highly economical operating cost over its range of stages up to between 1,200 and 1,600 miles.

Not for a long time are the supersonic airliners likely to appear on the short hauls of the air world and over half of all airline traffic is on the 200 to 1,200 miles stages. No other company is at de Havillands stage of having completed the design, signed the first order and pushed on into the structure testing, tooling and construction of a second and quite new short haul high speed airliner.

It is in the contribution towards development and tooling up costs and those of proving and producing aircraft ahead of firm orders that the Government help is to be given. It is for the air companies to respond, in the Comet tradition, by getting on to the airlines of the world with the new planes early enough for outstanding quality to lead to outstanding sales.

Bicycles and Steel Works for India

Whether or not the rising population prevents the full accompanying increase in living standards, the next five years for India are to see further great extension of industrial activity.

The third Five Year Plan lays down proposals for another 1,200 miles of railway lines, for a 100 per cent increase in electric power, for another 100,000 lorries and motor cars and a million bicycles.

With Durgapur in production with other new iron and steel works the ingot steel target has been raised to 10 million tons and pig iron to 1½ million.

As at least one Indian steel chief has said, with the Indian authorities intent on holding standards of consumption level, what is to be done with this output? The answer comes at two levels. So much of the basic work of building up the country's capacity towards the point where it generates its own wealth has still to be done that the constructional demand is enormous.

There are also the consumers. The third plan proposes to establish universal free primary education. This brings the end of mass illiteracy on the subcontinent within measurable distance. Small local factories, machine using and metal consuming, will inevitably follow. Their combined effort, as the population pushes on towards 500 million in the late 1960's is likely to change the familiar and difficult position in which the industrialised powers provide steel works and power stations like oases in an industrial desert.

The Indian demand for tools and many kinds of equipment carries with it the double challenge that the conditions of use will be very different—fewer facilities for repair, rather rapidly trained operatives, extremely tough conditions of climate in relation to wear and corrosion. And, on top of all that, no lack of competitors who also want the trade.

and a Never-Setting Sun

One problem that must beset anybody handling technical cooperation within the Commonwealth is the extent to which research results and engineering methods are affected by climatic and environmental conditions. Different situations call for variations in approach that may not always be apparent.

The British Commonwealth Scientific Committee now recovering from a tour of United Kingdom research establishments must be familiar with this question. Every Commonwealth country was represented, and Malaya has taken part for the first time. Subjects under discussion included oceanography, air pollution control, and astronomy.

The potential of the Antarctic and other permafrost regions may lead to new forms of industry and new technical problems. Sir William Slater, a member of the committee, speaking to a representative of ENGINEERING about an earlier tour in Canada, pointed out that in the far north, water had to be heated before entering the supply system, not only to prevent freezing up during distribution, but also as a means of maintaining sewage in adjacent mains at fluid temperatures.

He also described experiments at the Hannah Dairy Research Institute, Ayr, involving large calorimeters in which cows are held in order to check energy balance at different environmental temperatures and to select strains of cattle suitable for hot climates.

Formally constituted in 1958 at a meeting in Canada, the British Commonwealth Scientific Committee comprises the permanent heads of the four United Kingdom Research Councils (DSIR, the Agricultural Research Council, the Medical Research Council and the Nature Conservancy) and similar representatives from other countries.

Experience is Available to Tackle Corrosion

The National Chemical Laboratory, moved by thoughts such as saving part of the £600 million which it now costs the country annually in corrosion damage, offer to solve many of your problems.

The annual report of this organisation is now published. It makes interesting reading, particularly when talking about difficulties they have helped to straighten out. The following paragraphs are taken from the report. The laboratory is located at Teddington, Middlesex.

Immersed Corrosion

Corrosion in boilers and other hot water systems has again provided a large proportion of the inquiries about corrosion problems in immersed conditions. These included the corrosion of condensate return pipes, corrosion of boiler tubes and a request for suggestions for the best material of construction for an autoclave containing hot water contaminated with sulphur.

The use of myrabolam tannins in boiler feedwater treatment, and the possibilities of protecting boiler tubes with zinc and cadmium plating were methods of corrosion prevention about which further information was requested. More unusual methods involving the application of high-frequency electric current and use of other electrical devices were also encountered.

There were several enquiries illustrating problems arising from the corrosiveness of sea water or brine solutions. Among these were requests for methods for protection of copper coils from corrosion and abrasion in brine solution, the protection of ships' stern gear and an inhibitor for use in fire-extinguishing equipment where sodium chloride solution was used as a freezing-point depressant.

Examples covering a variety of metals include the corrosion of aluminium in anaesthetic equipment, the cracking of brass safety shutters in a hydrodynamics testing tank, the possibility of using an inhibitor for zinc in contact with dilute phosphoric acid, and the type of bronze to use for waters of high chloride and sulphate content.

There was a continued demand for information concerning the use of inhibitors, especially their use in cooling systems and in anti-freeze solutions.

Underground and Microbiological Corrosion

Nearly half the inquiries dealing with this aspect of corrosion were concerned with the prevention rather than the mitigation of corrosion. These mainly involved selection of the most suitable method of protecting underground piping systems. A good example of this was a request for an extensive microbiological soil survey prior to the laying of an underground oil pipeline.

Several of the failures encountered were caused by bad application of protective coatings. Others were apparently caused by electrolytic action brought about by stray currents in the ground or by using the pipe as an earth for electrical equipment.

Atmospheric Corrosion

As in the previous year most inquiries were concerned with suitable methods of protection, especially during storage and transit. These included preventing corrosion of scientific instruments, aluminium medallions, the aluminium bases of electric kettles and cadmium-plated machine parts, all being transported or stored in corrosive conditions.

Another inquirer wished to devise an accelerated test to discover whether aluminium would last longer than painted steel in extended storage under certain conditions. There were inquiries concerned with well-known tests such as the salt-spray test and the CRL beaker test.

Other inquiries dealt with filiform corrosion on the backs of clocks, methods of dealing with millscale to minimise corrosion, corrosion of plated mild steel screws in (hornbeam) wood piano parts, applications of volatile corrosion inhibitors, corrosion of galvanised steel refrigeration cabinets and corrosion of railway wagons by plumbago.

Purification Techniques

Over 200 inquiries on a variety of topics have been received during the year. Interest continues in zone-melting as a purification technique; some samples of organic compounds have been zone-melted at the request of a chemical firm and technical advice has been given to a firm of equipment makers regarding the design of semi-micro zone-melting apparatus. Inquiries from industry have visited the laboratory to discuss infra-red and ultra-violet recording spectrometers. Other inquiries dealt with have concerned the purification of phenanthrene and of alcohols, the best values for numerous physico-chemical constants, substances of established melting-point, thermostats, low temperature calorimetry, vapour-pressure measurements and glass bubble-cap fractionating columns. Among analytical problems on which information was sought were: the automatic recording of concentrations of ether in air, and the estimation of water in lubricating oil and in kerosine.

Eight hydrocarbon gas mixtures were analysed for the Gas Chromatography Working Group of the Institute of Petroleum as part of a study of gas chromatographic analysis.

Advice and help has also been given to various divisions of the National Physical Laboratory on such subjects as the preparation of pure hydrogen iodide, the filling of spherical glass and plastic ampoules with degassed pure water (for measurement of the gyromagnetic ratio of the proton), liquids suitable for use in determinations of the density of ice crystals, additives for reducing surface tension, methods for detecting " bubble " formation in veneer manufacture and the preparation of silicone rubbers.

Other Government laboratories were given advice on the packing of sensitive equipment at low humidity and on the distillation of phenol.

Decked Out with Neoprene

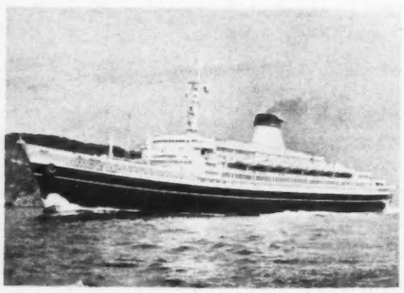
Italy's latest, sleekest liner, the Leonardo da Vinci, set sail on her maiden voyage to New York on 30 June. This 33,000 gross ton flagship of the Italian Line has a total capacity of 1,326 passengers and embodies many advanced techniques in naval construction.

Among the more significant of these techniques is the incorporation of neoprene synthetic-rubber decking compound in place of traditional wooden decking.

The decision to use neoprene decking compound was based on several advantages, practical and economical. The cost of laying a neoprene deck, for example, is less than half that of a wooden deck. Total weight of the decking is approximately 5½ lb per sq. ft compared with 8 to 9 lb per sq. ft for wood. Maintenance costs are considerably reduced because with neoprene decking such operations as resanding, recaulking, repairing and removal for corrosion checks are completely eliminated.

The anti-skid and flame resistant properties of neoprene were additional factors in choice of this material. Cement is made resistant to cracking by the addition of neoprene even when poured directly on to steel and exposed to the wide range of temperatures found on a ship during winter and summer cruising.

Decking of the Leonardo da Vinci was applied using a special undercut connection to a non-inflammable foundation made of neoprene latex, stabilised by adding mineral fillers. This 10 mm thick sub-floor ensures a flat surface to the deck in spite of the seams, joints and welding beads of the metal deck plates. As well as protecting the deck plates, the foundation provides a resilient support which completely absorbs all loads on the deck and closely bonds the decking to the deck plates, so forming a single body.



Neoprene decking compound on the Leonardo da Vinci prevents slipping and is flame-resistant and flexible.

Laying costs are less than half those of laying wooden decking and maintenance is reduced.

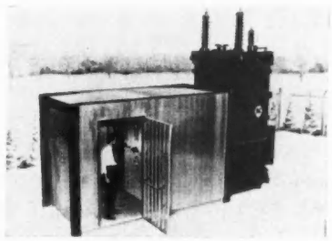
Not only has neoprene been chosen for the decking of the Leonardo, but miles of neoprene protective coatings are used in and around the ship.

Neoprene was the first general purpose synthetic rubber produced on a commercial scale in the United States. Introduced in 1931 by Du Pont as an entirely new kind of elastomeric material, it offered industry several important advantages over the natural polymer. A neoprene production plant is now operating outside the United States in Northern Ireland.

Interconnecting Aluminium Extrusions

Reynolds Metals have introduced a form of interlocking aluminium extrusion which looks promising for building up floors and walls. The company, showing the product at the Design Engineering Show in America, thought the extrusions to be invaluable for "airplane hangar doors, railroad refrigerator car floors and trailer truck floors." The top illustration shows the interlocking type of extrusion; the two sections, although having common interlocking flanges, are different in that the one on the left has longitudinal ribs. It is quite possible, of course, to extrude continuous ribs to act as treads on the upper surface as well, and this is done in the range of extrusions similar in purpose to this, but made by the Northern Aluminium Company in this country.

The lower illustration shows what happens when fact and fantasy are mixed in one photograph. Ignoring the artist's background, it



may be noted that Reynolds snap-lock extrusions were used in this Allis-Chalmers outdoor switchgear housing. The walls are water and weatherproof.

Reynolds Metals Company, Richmond 18, Virginia, USA.

Plastic Plus Metal Equals "Plastic Metal"

A new product has been introduced which is a mixture of an epoxide resin with powdered metal. In the latest version, the additive is lead. Previous to this have appeared "plastic steel" and "plastic aluminium." They are all Devcon products.

Devcon L (for lead) has the consistency of putty and can be moulded to shape as easily as can modelling clay. No heat, pressure or flame is required. Three hours after addition of a special hardening agent the mixture becomes a tough, rigid, strong mass very similar in all essential qualities to lead itself.

Developed originally for repairing lead-lined tanks and miscellaneous equipment used by chemical and allied industries, Devcon L was enthusiastically adopted in place of the conventional lead burning and in use, whether for repair or construction, it proved less expensive, less time-consuming and decidedly less dangerous than the traditional methods, since neither heat nor flame is necessary.

One chemical company constructed a new lead tank by simply trowelling it on the inside of a large wooden tank. The same company used it for bonding lead sheet to the inside of a cast-iron and steel cylinder.

The material is also used for the splicing and repair of lead-covered cables, such as are used by public utility and telephone companies, as well as for general maintenance work. Devcon L has excellent adherence to lead, aluminium, bronze, brass, wood, cast iron, porcelain, concrete, and can be used to bond these materials either to themselves or to each other.

Shrinkage is negligible during hardening: never more than of the order of 0·0005 in per in. It has high impact, compressive and tensile strengths.

E. P. Barrus (Concessionaires) Limited, 12-16 Brunel Road, Acton, London, W3.

High Temperature Refractory Mortar

A new all-purpose bonding and surfacing mortar, Amberset, designed to prolong the life of refractory brickwork, and for use at temperatures up to 1,650° C, has been developed by Amber Chemicals.

Amberset is an air-setting mortar which satisfies the requirements of super-duty class refractoriness, and at the same time provides a bond stronger than the brick itself.

Results of Modulus of Rupture. Tests to A STM C-198 C-133

Temperature, ° C	Modulus of rupture lb per sq. in
Dry	1,300–1,350
110	1,300–1,350
550	1,200–1,250
850	800–850
1,100	1,050–1,100
1,250	1,050–1,100
1,450	1,550–1,600
1,600	1,700–1,800

The mortar is resistant to thermal shock and has good expansile characteristics, enabling the joint to withstand thermal expansion and contraction stresses. Brickwork bonded with Amberset forms a solid unit, air and gas tight.

The very fine particle size of Amberset makes possible the use of extremely thin joints; this, in conjunction with the high bond strength, is an important factor in prolonging the life of refractories. Because of its smooth workability, Amberset can be readily applied as an impervious surface coating, thus further increasing the durability of the refractory.

Amberset is suitable for all types of industrial and marine boilers, heat-treatment furnaces, kilns, water gas producing plants and similar applications. It is supplied ready for use in 28 lb, 56 lb and 1 cwt drums.

Amber Chemical Company Limited, 11a Albemarle Street, London, W1.

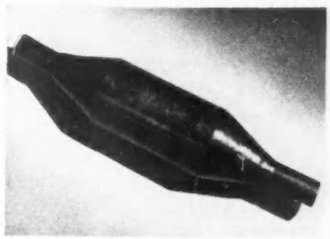
Plastic Cable Jointing Systems

Bakelite announce that they are now marketing a series of cable jointing methods using epoxide and polyester which have a number of technical and economic advantages over more conventional jointing materials. Several cable manufacturers have already approved use of these systems. Aerialite have come out with a method of making power cable joints which is based on materials such as these.

Bakelite epoxide resins possess good adhesion to most surfaces, particularly to metal conductors, armouring and most types of tape and, when used in cable jointing compounds, eliminate the need for cumbersome site heating equipment. Because of the inherent strength of cast epoxide resins, simple moulds made from thermoplastic sheet, pulp or similar materials are quite adequate and obviate use of costly metal joint boxes. The controllable quick-setting characteristics of these resins make quicker jointing possible.

Although epoxide resins are relatively expensive materials, their superior technical properties offset to a large extent their high initial cost. Of particular importance, too, is the fact that Bakelite has considerably reduced initial costs by introduction of a range of low-cost hardeners. The use of these hardeners, together with pitch or similar extenders, means that epoxide based jointing compounds can be obtained for as little as 3s 4d per lb.

The joint developed by Aerialite has been called the Plastic Power Cable Joint. It consists of a two-part mould—top and bottom—the top half being transparent and the bottom half supplied



in a range of colours, which may be used for colour coding for stocking purposes. In operation, this offers the great advantage of being able to see the resin poured and the joint being formed, through the transparent top, while the coloured bottom will serve for further identification purposes.

Aerialite joints have been subjected to electric and hydraulic pressure tests to ensure that there is no ingress of moisture between the resin and the cable sheath. This latter point is important, in that it ensures that in a system using pvc-sheathed, wire armoured, plastic insulated power cables and moulded resin joints, the armour wire is completely and permanently protected against corrosion and may be expected to maintain the desired earth conductivity throughout the entire life of the cable.

Because cast-iron or ceramic joint-boxes are eliminated, the individual jointing kits are light and easy to transport and store. A range of such joints, covering parallel branch and through-joints, as well as T-joints, will shortly be available and will be supplied as complete kits with the necessary jointing instructions from Aerialite.

Bakelite Limited, 12-18 Grosvenor Gardens, London, SW1.

Aerialite Limited, Castle Works, Stalybridge, Cheshire.

Heavy Duty Alkali Cleaner

A new general purpose degreasing agent of the alkali type is called Pyroclean No. 9. The material is supplied in a powder form and is used in aqueous solution within a temperature range of 190 to 205° F.

This agent is designed for cleaning iron and steel and can be used in still tanks, in automatic plants combining dip and spray, in orthodox spray cleaning machines and in the cleaning section of fully automatic metal pretreatment plants such as the Spra-Bonderizing installations.

The strength at which the solution is operated necessarily depends on the nature and amount of the oil, grease and dirt to be removed. Normally a strength in the range of 2 to 6 oz to the gallon of water is required, but in some production circumstances, a solution of reduced strength is employed.

Inspection of the components to be cleaned usually suffices, without further test, to determine the concentration at which the Pyroclean No. 9 should be operated. Preparation of the solution is then simply carried out by adding the requisite quantity of powder to the hot water. Processing time for an immersion plant is about 5 to 10 minutes; in a spray machine about 1 minute.

Pyrene Company Limited, Great West Road, Brentford, Middlesex.

Plain Words

By Capricorn

WHEN Gracie Fields delights us with her song about The Biggest Aspidistra in the World, she is not ridiculing the innocent aspidistra—she is taking the mickie out of us all and our primitive worship of the giant.

The worship of size is a besetting sin of engineers. If they are designing anything which is approaching the existing record for size, you can be sure they will quickly state a strong case for making it the biggest ever. They are not so foolish as to say that it should be the biggest just for the sake of the biggest—no one would listen to them if they did—so they rationalise the argument and bring in any factor which supports their contention.

I was talking recently to a man who is in a favourable position to note this tendency (he would not thank me for mentioning his name). He is not an engineer himself but he occupies a top post in one of our largest (there I go!) heavy engineering industries. He said engineers are always wanting to build bigger and better than anyone else. It is difficult for him to argue against them because in his industry the economies which come from employing large units are easy to see. He feels that, as a non-engineer among engineers, he must play devil's advocate so as to ensure that both sides of the size argument are heard.

One of the incidental advantages of big-building is that the accountants and other shrewd scrutineers will argue the toss about size, taking up most of the committee's time in this way, while behind the scenes the engineer can have great fun working out the really important technical innovations which he has in mind. He thus makes doubly sure that the professional institutions and the technical journals will vie with each other to get papers and articles on his masterpiece.

Brunel's Great Eastern, Churchward's locomotive The Great Bear, and recently the Brabazon airliner, were all of record size. Considered in isolation they were all failures, but they pointed the way to subsequent technical developments in their respective branches of engineering. I suppose that even hard-headed business men who are invited to raise capital for a giant piece of engineering can be won over by the prospect of association with something that may go down in history; though they are not sure whether as a white elephant or a gold mine.

Perhaps the Cunard Queens teach us the really important lesson about big-building: by all means cash in on it while the conditions allow, but watch out for the critical moment when you must pull out. At the Royal Lancashire Show which opens in Blackpool next week, I doubt whether there will be a competition for The Biggest Aspidistra in the World. Not even in Lancashire.

Aspidistras are out of fashion.

Letters to the Editor

The Life of Galileo

SIR, When Capricorn in his recent Plain Words (ENGNG., 8 July '60, p. 40), told us about his visit to the Mermaid Theatre, some of us naturally wanted to compare his impressions with our own. The play he saw was "The Life of Galileo," by Bertolt Brecht. "Bernard Miles as Galileo," says Capricorn, "succeeds in that most difficult dramatic enterprise—making the truth convincing."

But what sort of truth? Hardly, perhaps, scientific truth. Did the play as a whole present dramatic truth? After all, the dramatist is not necessarily concerned in telling you what happened. He may only inspire, exalt, stimulate, exasperate or infuriate the spectator into finding out for himself what happened. Engineers who saw the Galileo play may have found this line of inquiry very rewarding. They certainly would not accept Bertolt Brecht's dictum that the age of reason could have begun on 22 June, 1633, but didn't because on that date Galileo made his famous retraction. On the contrary, they might have been gratified to find that the middle years of the 17th century were exceptionally fruitful in scientific invention and discovery—particularly in the field of fluid mechanics.

And how glad we should be that this period was not exclusively an age of reason as Bertolt Brecht apparently wanted it to be—an age of just that kind of one-sided development that we are now trying to escape from. It was, in fact, the age of Milton and Murillo and Velasquez, and the age of Bunyan and Rembrandt and Dryden.

Yours faithfully,
HERBERT ADDISON.

56 Richmond Hill,
Richmond, Surrey.
18 July, 1960.

Cheaper and Quicker by Water

SIR, Your contributor of the article "Transport Cheaper and Quicker by Water" (ENGNG., 8 July '60, p. 56) makes some clearly expressed points on this theme. What he calls "pipeline," or as I would prefer to say, "conveyor belt" transport of components and materials from factory to factory is certainly very important in this industrial country, and waterway reliability as to delivery time is especially relevant thereto. To the interesting British Waterway's activities noted may be added the floating of a specially fitted conference barge. I may hire it myself for a Grand Contour Canal exhibition!

To try to enunciate the future interest in waterways in a few words, I would say that the main interest will stem from the facility of transport in large physical units which may be integral or made up by assembling barges in train or containers on a container carrier. The interest of large scale types (with simplicity of operation, low tare weight construction, etc.) will not lie in incidental transfers of traffic from other forms of carrier, but in the very many developments practicalised thereby, which, I predict, will be found to build up important and distinctive traffics.

In my national water grid article (15 July '60, p. 82) I mentioned, as must rarely be done in the press nowadays, the old Charnwood Forest Canal, an interesting primitive example whose short working life lay entirely in the 18th century period. It had no locks or navigable connections elsewhere but bore floats with two tracks for loaded coal tubs. Being on the level, all the fall available on the through route was saved up for the gravity tramway to which the tubs were transferred at Nanpantan, for the descent to Loughborough. It seems to have been a neat arrangement. Eventually there were a couple of breaches in the bank with tell-tale spade marks, and finally, in 1799, a more serious breach which lost all the water and discouraged the owners to the point of closure.

If one is a criminal saboteur it must give one tremendous satisfaction to be able—pardon the metaphor—to torpedo the object of one's venom with a spade!

Your faithfully,
J. F. POWNALL.

109 King's Road,
Cardiff.
16 July, 1960.

Machine Tool Statistics

SIR, One encounters from time to time such widely differing statistics for machine tool exports that I should like to refer to some of the figures quoted in the article "Machine Tool Firms React to Freer Trade," more particularly those relating to Italy (ENGNG., 17 June '60, p. 813).

I quote below your own figures for 1958 and those which were furnished by the Italian manufacturers' association based upon Italian official statistics:

	ENGINEERING	Italian Manufacturers
Imports	15,200 tons	7,851 tons
„ valued at	£13 million	£6·15 million
„ from United Kingdom ..	£825,000	£529,510
Exports to United Kingdom ..	£300,000	

To a much smaller extent I think there are discrepancies in the Belgian statistics, although most of these might be covered by "rounding-off" figures, such as 7,000 for 6·1 thousand, £4·5 million for £3·9 million, etc.!

Yours faithfully,
A. J. GIBBS SMITH.

477 Streetsbrook Road,
Solihull, Warwickshire.
12 July, 1960.

Visco-Plastic Deformations

SIR, The pressure-distribution around a buried body, such as a pipe or tunnel, when acted upon by a compressive load is important in establishing design criteria. Mathematical theories are available to give approximate pressure distribution equations which appear to operate satisfactorily in most practical cases, although it is a matter of opinion how far such theories are correct. With this in mind, a series of tests were carried out on a round object buried in an "earth" of Plasticine using the technique developed by the author and previously described in your columns (ENGNG., 18 Dec. '59, p. 646).

A piece of steel tube of approximately 1 in diameter was soldered securely to the back plate of the apparatus. Strips of Plasticine in various colours were packed around the tube from the base to the face of the piston. The piston which was to act as a load-applying pad was one which had been employed in the previous investigation and had adequate space at the sides to allow for the movement of displaced "earth." As shown in Fig. 1, the arrangement comprised five strips of Plasticine of one-quarter inch thickness above the tube and ten strips of Plasticine below the tube.

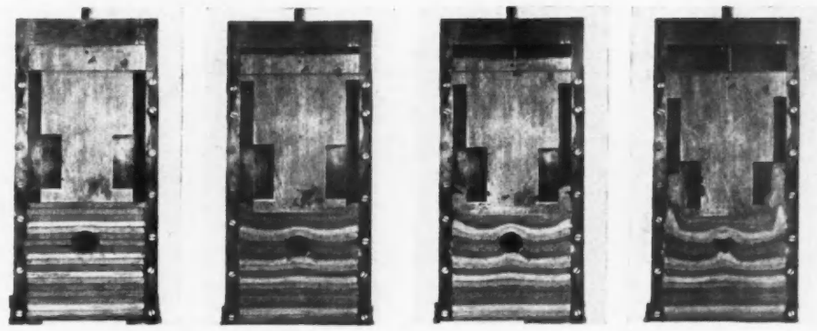
The result of three turns of the screw and the subsequent movement of the plate by about 0·3 in are shown in Fig. 2. This indicates a pattern of decidedly compressive loading above the cylinder, as shown by the thinning of the Plasticine strips, while below the cylinder the strips have gaps between them indicating a tensile distribution.

These effects appear more pronounced in the following figures as a result of greater penetration of the piston and the application of greater force.

A further series of tests using the same apparatus but with a piston of small base width gave the results shown in Figs. 5, 6, 7 and 8. In general, these results show movements and pressure-distributions of a similar character to those obtained with the wider piston. These,

Apparatus as set up with piston of wide-width base.

Fig. 1 As originally arranged. *Fig. 2 Deformation after 3 turns.* *Fig. 3 After 6 turns.* *Fig. 4 After 12 turns.*



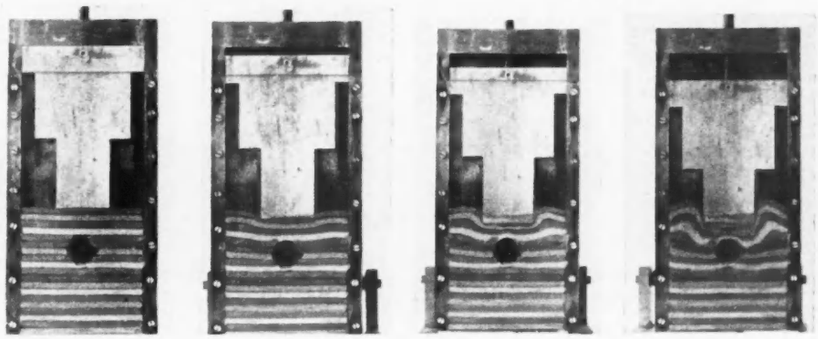


Fig. 5 As originally arranged. *Fig. 6 Deformation after 3 turns.* *Fig. 7 After 6 turns.* *Fig. 8 After 12 turns.*

Apparatus as set up with piston of narrow-width base.

in turn, indicate that under the application of a load of this nature the buried body would be likely to deform to a greater extent at the top than at the bottom.

Yours faithfully,

R. A. COLLACOTT,

Department of Mechanical Engineering.
Queen Mary College,
Mile End Road, London, E1.
30 June, 1960.

Events in Advance

Industrial Electronics Give Aid to Medicine

OCCUPYING the whole of the Empire Hall at Olympia, London, the first comprehensive exhibition of medical electronics was opened yesterday, 21 July, and will continue until Wednesday next, 27 July.

The exhibition is being held in conjunction with the Third International Conference on Medical Electronics, which is taking place at Olympia during the same period and is being attended by specialists from many parts of the world. Russian and American scientists for instance, will be among those contributing papers.

About one hundred firms are showing examples of their latest equipment in this field at the exhibition. Overseas representation is prominent, with exhibitors from some 20 countries, and includes apparatus from Japan and from certain Iron Curtain countries whose electronics industries are but newly established. A feature noteworthy in all sections of the exhibition, and especially characteristic of the British equipment, is the manner in which techniques recently developed for industrial purposes, such as automation, process control, and so on, have been adapted—often in a miniaturised and refined form—for new medical requirements.

In addition to manufacturers' own exhibits of equipment already in production and, quite often, in use, there is considerable emphasis on current research and development problems. An instance of this is the hospitals research section, to which 15 hospitals and medical institutions in this and other countries have contributed by displaying the results of their latest investigations: prototype apparatus and techniques which may not become standard medical practice for another five years or even longer. One of the many manufacturers' exhibits consists of sound-measuring equipment specially devised for surveys of noise intensity in factories and elsewhere, where its excess may have injurious effects on health. Another exhibit makes use of very-high-frequency sound for cleaning surgical instruments and glassware; an adaptation of a technique which has been employed industrially for some time for cleaning the metal parts used in various manufacturing processes.

The conference has been organised, in association with the International Federation for Medical Electronics, by the Electronics and Communications Section of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. Telephone COVent Garden 1871.

Advances in Refrigeration and Air Conditioning

The second International Refrigeration and Air Conditioning Exhibition, which will cover plant, equipment, machinery, insulation, controls and components, is due to be held at Earl's Court, London, SW5, from 11 to 16 April, 1961.

In this connection, a new organisation, formed to represent companies engaged in the refrigeration and air-conditioning industries which are to exhibit at this event, was brought into existence at a recent meeting in London.

The new body is to be known as The Refrigeration Industry Exhibitors' 1961 Group and one of its objects will be to ascertain the views of exhibitors about all exhibition arrangements and to make such necessary recommendations to the organiser as are judged to be in the best interests of the industry, exhibitors and visitors.

Among other aims of the organisation will be to ensure that exhibition space is fairly allocated by means of ballotting, should this course be necessary; to assist the organiser in gaining the widest support for the exhibition, through enlisting the cooperation of interested trade bodies at home and overseas; and to advise and assist the organiser with respect to future exhibitions, in accordance with the best interests of the industry.

A committee was appointed to represent the new group. Members of that committee include representatives of Marco Refrigerators Limited, Chrysler International CA, Refrigeration Spares Limited, Teddington Refrigeration Controls Limited, Minikay Limited, and Lec Refrigeration Limited. The organiser of the exhibition, Mr. Patrick Smyth, *World Refrigeration*, 11a Gloucester Road, South Kensington, London, SW7 (Tel. KNIghtsbridge 2945), has been appointed secretary to the new committee.

Exhibitions and Conferences

Applied Mechanics, 10th International Congress.—Wed., 31 Aug., to Wed., 7 Sept., at the Congress Building, Stressa.

Engine Testing of Crankcase Lubricating Oils, International Symposium.—Wed., 17 May, to Fri., 19 May, 1961, at Brighton. Organised by the Engine Tests of Lubricants Panel of the Institute of Petroleum. Offices of the Institute: 61 New Cavendish Street, London, W1. Tel. LANgham 3583.

Munich International Handicrafts and Trade Fair.—Wed., 31 May, to Sun., 11 June, 1961, at the exhibition grounds, Theresienhöhe, Munich. Offices: 14 Theresienhöhe, Munich, Germany.

Russian Trade Fair.—Fri., 7 July, to Sat., 29 July, 1961, at Earl's Court, London, SW5. Organised by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Sydney Trade Fair.—Tues., 1 Aug., to Sat., 12 Aug., 1961, in Sydney, Australia. Apply to Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Energy, Conference on New Sources of.—Thurs., 17 Aug., to Sun., 27 Aug., 1961, in Europe. Sponsored by the United Nations. Apply to the Office of Public Information, United Nations, New York, USA.

Factory Equipment Exhibition, Ninth.—Mon., 13 Nov., to Sat., 18 Nov., 1961, at Earl's Court, London, SW5. Organised by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Engineering Materials and Design Exhibition, Second.—Mon., 13 Nov., to Sat., 18 Nov., 1961, at Earl's Court, London, SW5. Organised by Industrial and Trade Exhibitions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Century 21 Exposition.—Sat., 21 April, to Sun., 21 Oct., 1962, at Seattle 9, Washington, USA. Stated to be the first international exposition in the United States since 1939. Under the patronage of the United States Government. Theme: "Man in the Space Age." Apply to the director of information, Century 21 Exposition, Exposition Building, Seattle 9, Washington, USA.

Compressed Air and Hydraulics Exhibition and Conference, Second International.—Mon., 30 April, to Fri., 4 May, 1962, at Olympia, London, W14. Organised by *Fluid Power, Incorporating Compressed Air and Hydraulics*, St. Richard's House, Eversholt Street, London, NW1. Tel. EUSton 7293.

Laboratory, Measurement and Automation Techniques in Chemistry, Second International Congress and Exhibition (ILMAC).—Mon., 15 Oct., to Sat., 20 Oct., 1962, in the buildings of the Swiss Industries Fair at Basle. Apply to ILMAC, 61 Clarastrasse, Basle, Switzerland.

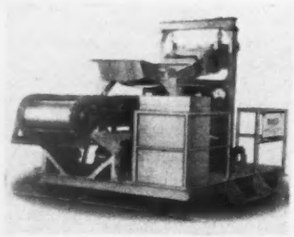
CONSTANT WEIGHT FEEDER

Pulverised Fuel

A NEW design of constant weight feeder has been developed for proportioning pulverised fuel to be used for coking.

The equipment comprises an electromagnetic vibratory feeder which draws pulverised fuel from overhead bunkers and feeds it to a constant speed belt. The belt assembly is so mounted that only 10 per cent of its weight is taken on the weighing machine and therefore 10 per cent of any weight variation is measured continuously.

To sense these variations the weighing machine is fitted with contactless detectors in the form of aircored transformers which only pass current when a steel blade passes between the coils. The blade is attached to the balance arm and any deflection causes it to enter either the high or the low coil. The resulting current is applied to the grid of a thyratron, the anode current of which energises the feeder. Thus corrections are made and the amount of material passing is held constant.



The existing machine has a throughput of 100 metric tons per hour and the weight delivered is held constant to within 1 per cent. The control circuits also contain compensating circuits to take into account various factors and the control desk for the whole installation is mounted on the equipment platform. It is sufficiently robust to stand up to normal gas works conditions. The feeders are mounted on rails so each can serve several hoppers; for example in one installation there are six feeders which between them draw from 15 overhead hoppers to obtain the required mix for the coking ovens. *Sinex Engineering Company Limited, Feltham, Middlesex.*

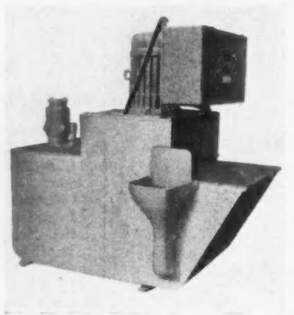
CLARIFIER

For Grinding Coolants

THE Turbomatic Minor is a centrifuge for the clarification of grinding coolants, with a rated capacity of 13 gallons per minute.

The bowl of the machine is automatically cleaned by a time operated cam device. The tank on which the bowl is mounted forms a reservoir of 58 gallons capacity. It is divided into two compartments one of which receives contaminated coolant and allows some settlement to take place, while the other receives the cleaned coolant after it has passed through the centrifuge. Sludge is discharged at the predetermined time by reversing the current to the motor to decelerate the bowl rapidly, the solids being scoured from the sides by the remaining coolant and discharged during the short interval before the motor is restarted. The action is fully automatic. Accumulated sludge can be raked out.

The machine has a rated capacity of 750 gallons per hour for a bowl speed of 1,425 r.p.m. Accelerating time is from 1 to 2 seconds and liquid pickup



time from 10 to 12 seconds. Braking time is 2½ to 3½ seconds. Power is normally supplied by a 3 h.p. motor, flange mounted, working from 440V mains and drawing 20A at starting. Braking current is 30A. The machine measures 48 in by 24 in across the tank (excluding the tundish) and stands 43½ in high. Across the feet the tank measures 27½ in. *Alfa-Laval Company Limited, Great West Road, Brentford, Middlesex.*

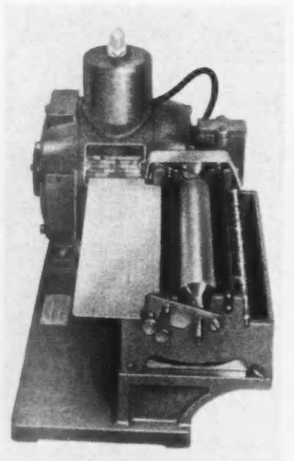
APPLICATOR

For Gumming Labels

THE Beatall range of machines for gumming labels has recently been redesigned.

There are five sizes made with roller widths of 6 in, 8 in, 10 in, 12 in, and 14 in. They are designed for reasonably constant use on applications before and up to the need for fully automatic machines. Any size or shape of label within the widths mentioned can be handled, no adjustment being required for length.

Each machine is powered by a drip-proof ¼ h.p. motor with gear reduction, and has a top mounted switch. The whole assembly, together with the gum box, feed and delivery units, is mounted on a solid one-piece base. Operation is simple. The gum is mixed with water to the required consistency and poured into the gum box till it is about ¼ in above the bottom of the main roller. An adjustable scraper is provided to control the amount of gum applied. The motor is switched on and the lables fed under the guide roller when they are



automatically drawn across the gumming roller, and delivered ready for application. *Farrow and Jackson Limited, 41/42 Prescot Street, London, E1.*

COMPRESSORS

Up to 1,200 lb per sq. in

RECIPROCATING compressors in the new standard range 300/A include single double and three stage models working up to 1,200 lb per sq. in.

There are three versions with lengths of stroke of 6 in, 8 in and 12 in, all of which can be supplied in one, two or three stages. The 6 in stroke machine can be supplied with one, two, or three cranks and the others with either two or three cranks. From the 12 in machine the maximum flow of air that can be obtained is about 3,600 cu. ft per minute at a discharge pressure of 100 lb per sq. in.

Drop forged I section connecting rods have been used with a high strength to weight ratio and a reduction of out-of-balance forces. Special attention has been given to the interchangeability of parts. The big end and main bearings have thick wall steel backs and white metal linings; they can be fitted without bedding or scraping. The crank frame doors are light alloy and can be removed by one man. The machines have been

designed for continuous running and easy maintenance.

The cylinder has the suction and delivery valves vertically disposed round the walls, improving accessibility and giving direct entry to the cylinder and piston. A centrifugal oil cleaner is incorporated, driven by the oil pressure; it will filter down to 5 microns. A water-cooled oil cooler has been incorporated with base plate. *Bryan Donkin Company Limited, Chesterfield.*

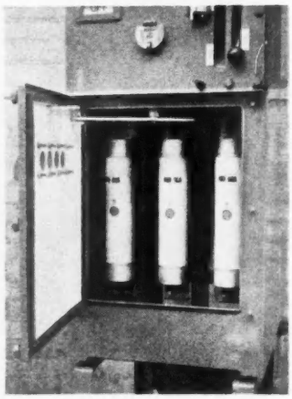
SWITCH FUSE UNIT

250 MVA Rating

A NEW range of LEL switch fuse links has ratings up to 90A at 11 kV and rupturing capacity of 250 MVA.

These units are the powder filled type for use in air and have been tested at KEMA and ASTA for both top and lower ratings. The fuse links are the current-limiting pattern and consist of pure silver wire or strip (depending on the current rating) wound helically on carriers of ceramic material. They are surrounded by pure silica sand and contained in a ceramic barrel having copper end ferrules. A pilot fuse fed through the centre operates a striker pin which in turn operates the switch tripping mechanism.

The complete unit has an air insulated chamber and can be used for protecting transformers up to 1,500 kVA rating at 11 kV. There are 13 links in the range covering voltages of 3·3 kV, 6·6 kV and 11 kV. Fuses for 3·3 kV are available in 10 and 100A sizes with ratings of 75 and 150 MVA for both. In the 6·6 kV size ratings are for 10,



75, and 125A with rupturing capacities of 150 and 250 MVA. The four 11 kV models have current ratings of 10, 50, 70 and 90A, all with rupturing capacities of 250 MVA. The complete switch fuse unit is suitable for use either in or outdoors. *Brush Electrical Engineering Company Limited, Loughborough.*

HAMMER DRILL

For Corners

A NEW hammer drill, the model ZL13/A, has been introduced to the Duax range of two speed drills particularly for making large holes in close corners.

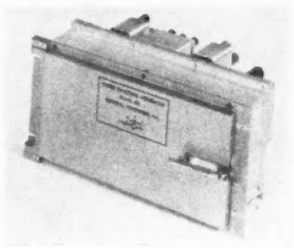
A special application is in the installation of small bore heating systems where the pipes have to pass through the skirting boards and walls as close to the corner as possible. Holes can be made in wood, concrete or brick, using only one drill.

The operator can change the speed of the drill from 1,300 to 500 r.p.m. to suit the work in hand, while hammer blows can be brought into operation at rates of either 13,000 or 7,500 per min. Special solid and hollow types of tungsten carbide drills will work in hard stone up to diameters of 2½ in and to depths of 14 in.

Alternatively, by removing the hammer head from the tool, it becomes a standard ½ in heavy duty drill that can be used for all normal purposes. A drill stand is available for use with it. *Trend Industrial Equipment Limited, 77 and 95 Dudden Hill Lane, London, NW10.*

FUNCTION GENERATOR

Punched Card Memory



A PUNCHED card memory enables programming to be carried out in seconds on the type 100 diode function generator.

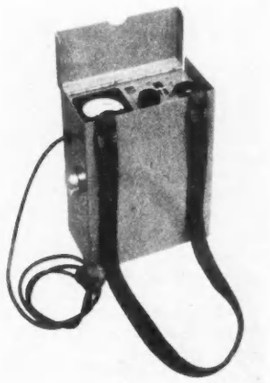
The instrument is a general purpose unit utilising computing amplifiers, silicon junction diodes and precision resistors to generate an output voltage which is a programmed function of the input voltage. This function may be represented graphically by 20 continuous line segments, the zero offset and slope at breakpoint being set by punched card. The former may be programmed to any value in the range ± 100 volts to within 0·125 volts and the range may be compressed by any integral factor up to 8. Slope values are cumulative from the point of origin, and changes may be programmed to any value in the range of $\pm 1{\cdot}27$ volts/volt to within $\pm 0{\cdot}005$ v/v. The entire function can also be scaled up by any integral multiplier up to 8.

The break points, which are set by plug in assemblies, are normally supplied in multiples of 10 volts referred to the input. Each is independent of the others, and each may be used for either positive or negative break.

The internal programming occurs as the door is closed over the punched card. Spring loaded plungers in the door pass the holes that have been punched in the card and actuate sealed switches. There are no other moving parts. Absolute accuracy is to within 0·1 per cent and long term repeatability to 0·02 per cent. Fequency response is from d.c. up to 10 kc. *General Computers Incorporated, 9000 West Pico Boulevard, Los Angeles 35, California, USA.*

ALLOY DETECTOR

Non-Ferrous Metals



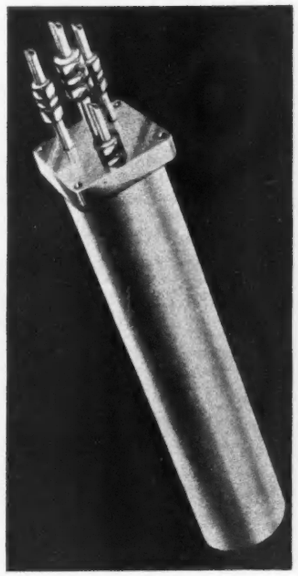
THE Sortationer is an instrument that has been devised for differentiating between various alloys of copper, aluminium, and magnesium.

The sensing head, which does not have to be square on the surface and is not affected by anodising or painting, contains a coil that may be considered as the primary of a transformer fed with a low frequency supply. The sample under investigation can then be regarded as a single shorted-turn secondary winding. The inductance of the primary coil and its losses are affected by the differences in the electrical characteristics of the material under test. Reductions in inductance raise the tuned frequency, and increases in loss lower its efficiency. Both effects occur with non-ferrous metals.

The instrument is normally used to identify materials that have lost their identity marks, or to show the degree of heat treatment. It will identify with certainty aluminium and magnesium from their alloys and will sort remaining materials into stacks that can usually be identified by appearance or analysis. A particular application is to indicate which side of a single sided aluminium coated shell is clad. It will also show in many cases any heat treatment damage. *Townson and Mercer Limited, Beddington Lane, Croydon.*

HEAT EXCHANGER

Up to 3,000 lb per sq. in



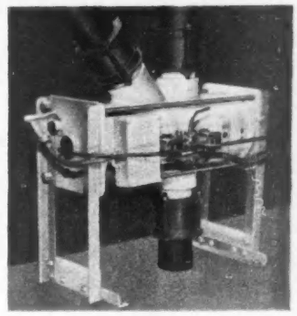
PRIMARILY designed for use with mechanical shaft seals operating at high temperatures, the heat dissipator can be used also as a normal heat exchanger.

The unit consists of two main parts: the element of stainless steel tube, and the shell and cap also of stainless steel. The element is silver soldered into a stainless steel end plate and is pressure tested to 3,000 lb per sq. in. The product does not come into contact with the solder. The shell is made of seamless tube $3\frac{7}{16}$ in outside diameter, pressure tested to 200 lb per sq. in. The cap is sealed into it by an O ring. The overall length of the unit is 15 in.

The unit is capable of dissipating up to 10,000 Btu per hour with a maximum working temperature of 180° F. It is normally mounted with the tube connections upwards to avoid entrapping air, but will operate in most positions providing all air locks are eliminated before starting up. *Crane Packing Limited, Slough, Buckinghamshire.*

DIVERTER VALVE

For Pneumatic Conveyors



TO ALLOW switching in pneumatic conveying systems, a diverter valve has been introduced.

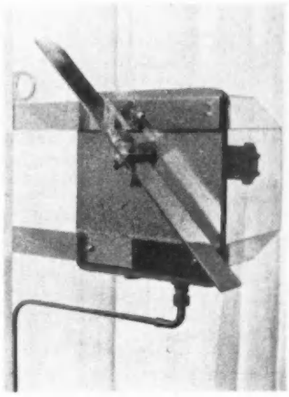
The valve can be supplied with either a single acting solenoid and spring return, or with double solenoid allowing it to remain in either position indefinitely. An adjustable cushioned end cap is fitted to valves required for high speed operation, and a solenoid control valve is also available which allows air to enter the cylinder at a faster rate.

The valve consists of a cast iron casing with an inlet bore and two outlets at 40°. Steel sleeves rolled into the cast iron of the cylinder body enable a tight connection to be made to the blowing lines by couplings. The piston has two ports and by changing its position in the cylinder the conveying air and stock passes through one or other of the outlet pipes. The valve unit is available in a range of bore sizes.

The piston is moved by compressed air admitted through the end caps. The air is controlled by a solenoid operated piston valve which permits entry to one side of the main piston and at the same time exhausts the other. Air pressure required is 60 lb per sq. in. Micro switches can be fitted to the end caps to provide indication of movement or to incorporate the valve into an automatic sequencing system. Manual control valves are also available operated by handwheel or chainwheel according to the application. *Thomas Robinson and Son Limited, Rochdale.*

LEVEL CONTROLLER

Air Operated



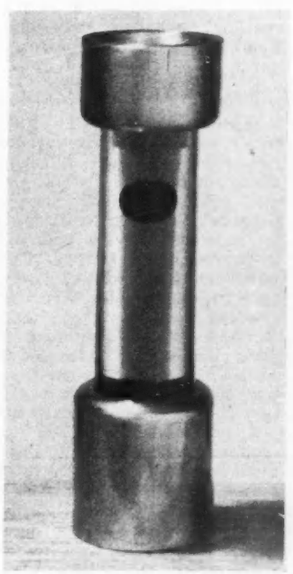
THE Bindex is a bin level controller which is operated by compressed air and can be used with most materials including cohesive ones.

The device consists of a casing about 9 in square which houses a pressure valve, a pressure switch, and an air motor. Outside the casing is a simple paddle normally 16 in long connected to the air motor by a spindle passing through the bin wall or roof. The paddle is made to oscillate by the air motor giving a seesaw movement until it is impeded by the presence of material in the bin. Interference with the movement immediately activates the pressure switch which operates a light, sounds an alarm, or initiates controlling action to the equipment feeding the bin. The pressure valve can be adjusted to give indication even with materials that offer little resistance to the movement of the paddle.

A $1\frac{1}{2}$ in diameter hole is required through the wall or roof to accommodate the spindle, and the paddle can be shaped to suit the inside wall. The minimum air supply is 15 lb per sq. in and the approximate consumption is 0·19 cu. ft per minute. On multiple installations a common reducing valve will serve all instruments. Electrical apparatus can be far from the bin. *Henry Simon Limited, Stockport, Cheshire.*

FLOW INDICATOR

For Lubricants



IT IS claimed for a new range of flow indicators for lubricants that they overcome the difficulties of operation failure and misting up associated with additive oils.

Basically the indicators consist of a ball in a transparent tube with a tapered bore, so arranged that the ball rises in the tube as the flow increases. Working pressures are up to 1,000 lb per sq. in. There are three forms: the standard unit; a replacement unit (illustrated) and a multi-point installation.

The standard unit has a single sight tube in a brass body with screwed ends to take Simplex couplings. It is suitable for flows in the range from 0·2 cc per minute to 4 cc per minute. The replacement unit is designed to take the place of an existing flow indicator; it has brass end adaptors to fit it directly in place of a sight glass. Three lengths are made and the flow range covered is from 0·1 cc to 2 cc per minute. *Alan Muntz and Company Limited, Browells Lane, Feltham, Middlesex.*

A Debt to Fellows of the Royal Society

The second Charter of the Royal Society bade the Fellows apply their studies to the advantage of the human race. It is not surprising therefore that engineering is indebted to Fellows of the Royal Society.

By Sir Harold Hartley, G.C.V.O., F.R.S.

KING CHARLES II, the founder and patron of the Royal Society, in its second charter of 1663, bade the Fellows apply their studies "to the advantage of the human race." Encouraged by the presence of Moray and Bruce, both with industrial and business interests, and of William Petty, the founder of economic statistics, Charles was no doubt hoping for some practical results from their work. When he teased them "for spending time in weighing only air," he may well have had a material motive in his mind.

INVENTION AND EXPERIMENT

In their early meetings they often discussed industrial problems, and they had committees on Mechanical Inventions and on Histories of Trade. In Robert Hooke their Curator of Experiments, they had one of the most prolific investigators and inventors of all time, remembered today as the founder of meteorology, for Hooke's Law, for his universal or Hooke's joint, the first dividing engine, the spiral gear, and the balance spring of watches.

The interest of the Fellows in astronomy was due in no small part to their concern with the problems of navigation. John Wilkins, the Jules Verne of his generation, who presided at the founding meeting, wrote about the possibility of journeys to the moon and in his *Mathematical Magick* he discussed the "flying Chariot" and "an Ark for submarine Navigations." So there was justification for the King's optimism.

As the work of the Fellows matured and assumed more and more the character of modern investigation, it supplied the background of scientific knowledge which later was to contribute to the development of new engineering techniques. The influence of the Fellowship was rarely due to any corporate action of the Society but to the individual labours of the Fellows and their discoveries and inventions.

In the industrial expansion of Britain in the 18th century the growth of the factory system was dependent on the development of machines driven by water power or steam, on supplies of coal and minerals and on improved transport. In all these fields the Fellows played a prominent part.

PRACTICAL ARTS MADE WELCOME

Matthew Boulton and Josiah Wedgwood were pioneers of factory production, and a remarkable succession of engineers, Smeaton, Brunel, Rennie and Telford, not only designed and constructed vastly improved means of transport, with their roads, bridges and canals, but their technical skill found other outlets such as Rennie's mills. Cartwright designed the first power loom; Wilkinson cast and bored the accurate cylinders for Watt's engine; Howard invented the vacuum pan for sugar refining; Roebuck the lead chamber for making sulphuric acid; and Bryan Donkin constructed the first British power-driven paper mill. In all these ways the Fellowship made its contribution to the earlier stages of the Industrial Revolution.

Just when the supplies of water power were becoming adequate and the production of more coal and ores was increasingly dependent on more power to pump water from the mines, Watt's steam engine, developed with the imaginative support of Matthew Boulton, gave birth to a new age. First used to drive the pumps in the tin mines in Cornwall, it was quickly developed into a rotative engine to drive machines.

When J. L. Henderson said that science owed more to the steam engine than the steam engine owed to science he was thinking no doubt of its stimulus to thermodynamics and of Carnot's and Rankine's cycles and he was forgetting that Watt's flash of inspiration which produced the condensing engine was derived from his friend Black's discovery of latent heat. This example of the interplay of discovery and invention is typical of the evolution of machines and techniques both to meet and provoke the demands of modern society.

Progress produced fresh problems. Deeper mines brought the danger of mine gases and an appeal to Humphry Davy led to one of his most brilliant investigations which ended in his safety lamp. Cathodic protection against corrosion, so widely applied today, was also Davy's invention devised to meet the need to protect the copper sheeting of naval ships.

SOPHISTICATION AND PRECISION

Towards the end of the 19th century engineering became more sophisticated and its development gradually became more dependent on scientific progress. The contributions of the Fellowship came mainly from three directions. New discoveries like Faraday's electromagnetic induction brought into being new industries and new techniques; applied mathematicians like Rankine and Lanchester did much to remove empiricism from engineering design; and new inventions like Parson's turbine and Whittle's jet engine changed fundamentally the path of development.

One of the features of the 1851 Exhibition was the display of machine tools made by Sir Joseph Whitworth who was mainly responsible for bringing standardisation and precision into the manufacture of machinery in Britain. His classic work on uniform screw threads, his machine for measuring to one-millionth part of an inch, his system of end-measurement added to his genius in designing machine tools, opened the way to the mass production of consumer goods.

ELECTROMAGNETIC PROGENY

The electrical industry stems from Faraday's discovery, and in its gradual progress the Fellowship intervened at some decisive moments. The first application of electricity was for communication, in which Wheatstone on land and Kelvin by sea were the pioneers. Its use in the home and industry was helped by Wilde's dynamo and Swan's incandescent lamp. The earliest power stations supplied direct current for lighting in their immediate neighbourhood, until in 1891 Ferranti's success in building a power station outside London to supply alternating current through high-voltage cables set the pattern for the future. A little later Parsons' steam turbine made possible the huge generators we use today with their manifold economies.

Meanwhile, Faraday's theories based on his experimental researches were given mathematical form and precision in Clerk Maxwell's electromagnetic theory, which prompted Hertz to investigate resonating circuits, the starting point of radio communication.

ELECTRONS AND THE NUCLEUS

J. J. Thomson and Rutherford were the heirs to Faraday's tradition of experiment and their discoveries of the electron and the nuclear atom opened new vistas. The new science of electronics with Fleming's valve and Appleton's discovery of the ionosphere led on to the development of radar by Watson-Watt, helped by Randall's magnetron, and eventually to radio astronomy.

Control engineering started with Watt's governor and Clerk Maxwell's classic paper "On Governors," and now electronics have provided it with devices far swifter and more accurate than the human senses. Electronics also made possible the modern computer which, with its speed and memory, has intensified so much the power of the human brain. In its development Williams and Wilkes were pioneers. Then in power engineering the development of the nuclear reactor, associated in Britain with the names of Hinton and Cockcroft, has removed any fear that the world may be short of energy in the future.

MATERIALS AND MATHEMATICS

There are many other examples of this interplay of science and engineering in which the Fellowship has played a part. The first iron ships were built by Brunel and Rennie. Bessemer, Siemens and Gilchrist left their mark in the production of steel, and Hadfield was the pioneer of alloy steels. The science of metallography dates from Sorby's pioneer work on the microscopic structure of metals in 1864, developed later by Roberts-Austen, Carpenter and Rosenhain.

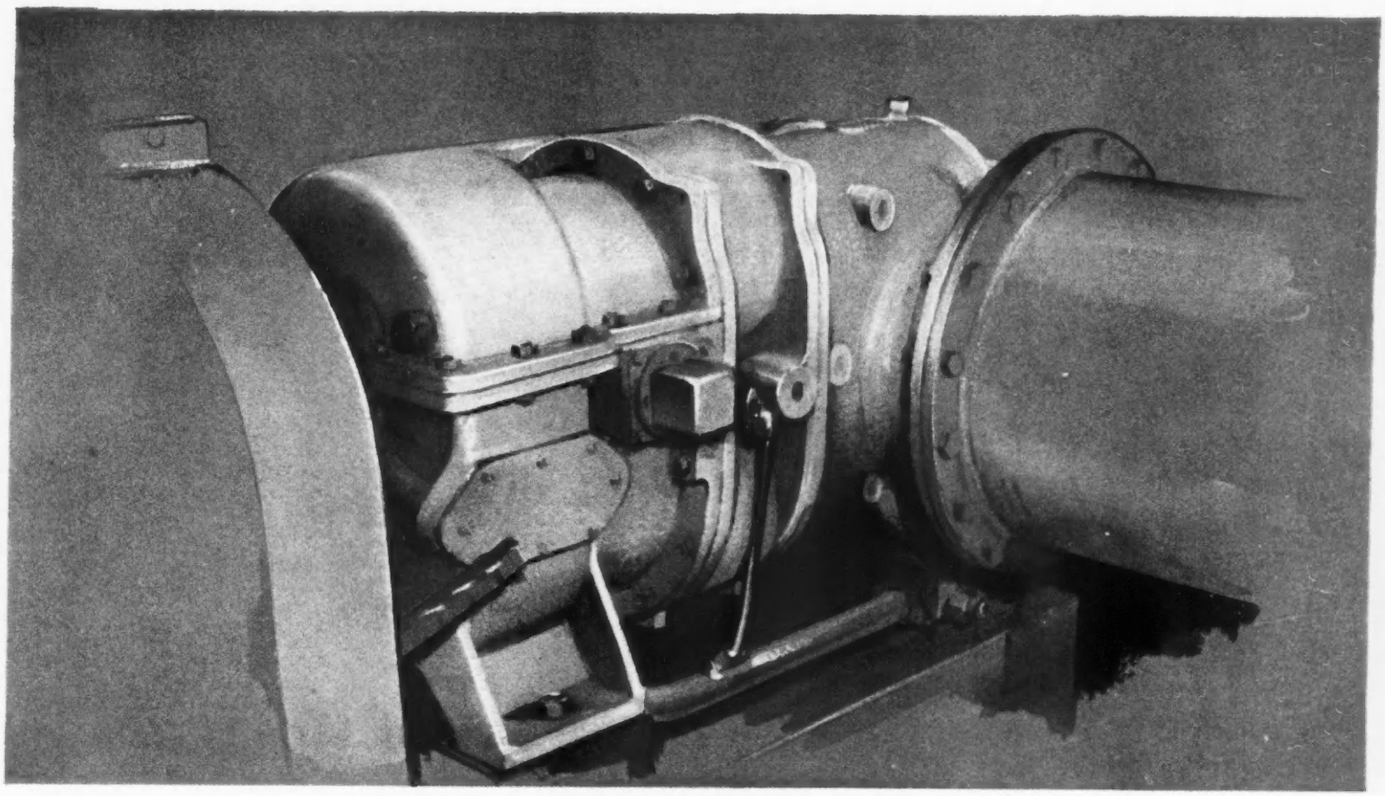
In the chemical industry artificial fertilisers date from Lawes and Gilbert's work at Rothamsted, synthetic dyes originated with W. H. Perkin, antibiotics had their great stimulus from Fleming and Florey, and Ludwig Mond was the progenitor of chemical engineering. As far back as 1664 Robert Hooke had foreseen the possibility of producing an artificial glutinous composition which resembles the substance out of which the silk worm wire-draws his "clue", and of "drawing it into such wires for use". In 1892 Cross was the co-discoverer of the viscous process for making an artificial silk which gave birth to the rayon industry.

Turning to the contributions of scientific research and applied mathematics, few investigations can have more general application in engineering practice than the work of Osborn Reynolds on fluid flow. Geoffrey Taylor's theory of turbulence is the foundation of modern meteorology with all its implications for industry and agriculture, and his study of the behaviour of crystals of aluminium broke fresh ground in the structure of metals. He was the first to analyse slip deformation in terms of the resolved stresses and the crystallography of the slip planes. Alan Wilson's theory of the solid state stimulated the study of semiconductors which led on to the development of the transistor with its many advantages and uses.

In aeronautics Bryan's theory of stability and Lanchester's analysis of lift and drag provided a scientific basis for design which set the pattern for later fellows like Melville Jones and Goldstein to enlarge upon. Lanchester's contribution to aviation was only one of the products of his fertile brain, as in the early days of the motor car he gave it its modern form and originated so many of its components that we use today.

ADVANTAGE OF THE HUMAN RACE

In the year of the Tercentenary Celebrations it is appropriate to look back and see how far the Fellowship has fulfilled the hopes of the Royal Founder. Many other names of Fellows who have contributed to the progress of engineering and engineering science might be quoted, Robert Stephenson and Heaviside are obvious omissions, but enough has been said to show how well the Fellows through the centuries have obeyed the instructions in their charter to apply their researches "to the advantage of the human race."



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They are perfectly balanced and are run at high speeds without vibration, so that lighter foundations can be used. They occupy very little floor space.
They are valveless and simple, so that maintenance cost and lost time are reduced. Their flow is pulseless, so that small receivers can be used.
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HOWDEN are the only manufacturers in Britain making these compressors for stationary industrial applications and are the only British manufacturers with world selling rights for these compressors for stationary industrial applications.

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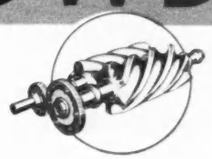

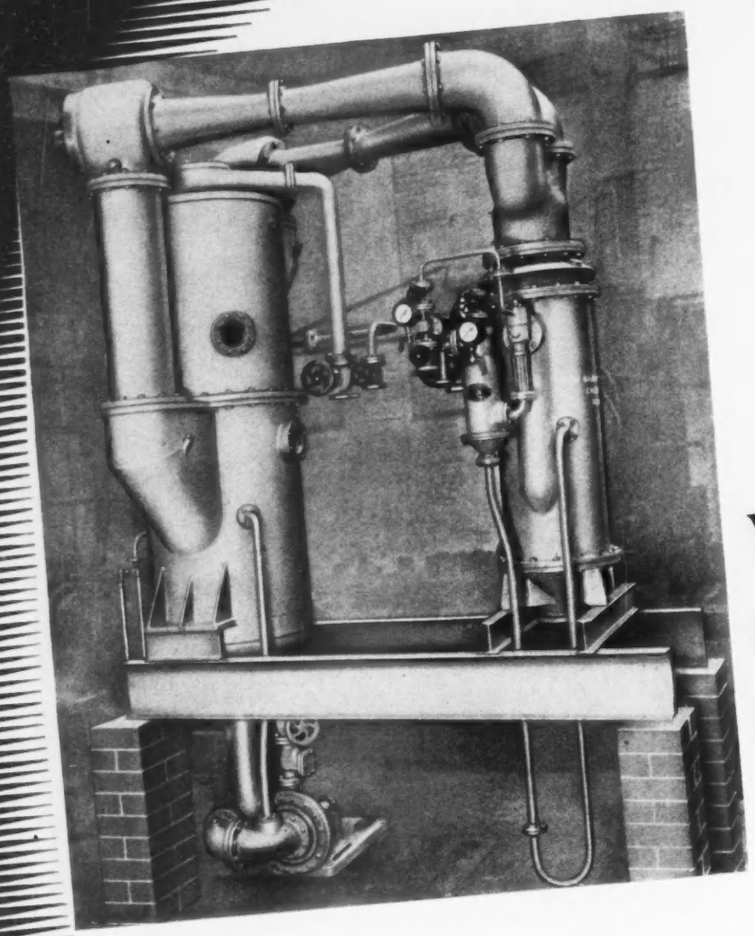

Vacuum Chilling Plant

Vacuum Chilling Plant for cooling water to a temperature of 45° F. with an ambient temperature of 85° F. Particularly suitable for process operation when there is a considerable demand for low grade heat.

Hick Hargreaves have supplied many Vacuum Chilling Plants for a wide variety of industrial process requirements.

The unit is self-contained embodying vacuum augmentors which compress the flashed vapour from the cooling vessel which is discharged to a jet condenser. The chilled water is withdrawn from the cooling vessel by a Hivac extraction pump.

Hick Hargreaves

AND COMPANY LTD · BOLTON

Human Element

Pirelli Start New Apprenticeship Scheme

YOUNG men who elect to broaden their education by staying at school until 17 will not be lessening their chances of entering an apprenticeship as the result of a new Pirelli scheme to be operated at the company's Burton-on-Trent works.

Many apprenticeships start at 16 but the Pirelli scheme will give the company the benefit of taking into their employment boys who have gained a further year of school training before launching themselves into industry.

The scheme is for a five-year apprenticeship, open to grammar or technical school boys who have obtained five "O" level passes in the GCE examination. Two of the subjects must be mathematics and English language. Provision has been made for accepting boys against their expected GCE results.

For six months the apprentice will be in a trial period while he discovers if he is going to settle down to industrial employment. Once over that hurdle, the student apprentice will go through machine shop, drawing office, work study and engineering practice and each phase of the company's production of tyres, resilient webbing and footwear. The fifth year will include a period of attachment to production supervision in order to gain acquaintance with management problems.

Once past the first six months, the trade apprentices begin technical courses in the engineering departments, the main emphasis being upon machine shop practice and machinery maintenance. Final year apprentices will spend part of their time in the stores, the drawing office and learning tool fitting.

Time out for attendance at the local technical college will be allowed to student and trade apprentices.

Legalising the Art of Domestic Firelighting

It was probably never intended by the most ardent exponent of clean air that the national art of burning up paper and sticks, and quite a number of matches, all in the name of firelighting, should be obliterated along with the factory fumes, the massive pollution from domestic boilers and raw coal open hearths.

Crouching on the carpet blowing in imitation of the bellows and frantically calling for more copies of the newspaper was never exactly efficient, but occasionally there were days of fire-in-one triumph that more than compensated for the days of failure.

Who would risk pouring all that grey and sluggish smoke up the chimney before getting the smokeless coal alight when an inspector from the Town Hall might spot the offending cloud? Probably all too many. For while being forbidden to burn air polluting raw coal is a reasonable curtailment of liberty that it is common sense to accept, the infringement of our dignity as firelighters of passing skill would be too much.

The upshot, as so often, is a Ministry circular. In this case a circular from the Minister of Housing, Mr. Henry Brooke, pointing out that local authorities can best cover the use of sticks and paper for firelighting under the exemption powers of the Clean Air Act, 1956, Section II (3).

The exemption is for houses where "town gas" is not laid on and only applies where approved fuels and kindling sticks are being used. For, as Mr. Brooke says, there may be people who object to having gas in their houses.

It is hardly likely that hardened sticks-and-paper men will develop objections to town gas and have the cooker, pipes and all, put out in the garden. But Mr. Brooke has spoken a kindly word for those to whom the gas poker is no substitute for their own hard won understanding of the fire-raising qualities of the local paper.

No Holiday Change for Midland Car Workers

Powerful indeed are the vested interests that want the present too short and too crowded holiday season to stay the way it is. Despite the fact that its children take the Northern Universities examinations the Birmingham education authority has said it could not deal with the situation that would arise if the annual two-week car workers' holidays were advanced to the first two weeks in July. Oxford and Coventry education authorities said that there would be difficulties but that they could cope. At present, and again for next year, the holiday is the last week in July and the first in August.

The decision not to change the 1961 holiday dates was taken at a recent meeting between the Birmingham Engineering and Allied Employers' Association and the local district Confederation of Shipbuilding and Engineering Unions. Birmingham car workers voted heavily in favour of the change earlier in the year. The strength of the 250,000 car workers' desire for the change received a serious blow when the important group of workers at the Vauxhall plant, in Luton, voted against the change.

At Luton it is customary for Vauxhall, Electrolux and Skefko, the three main plants in the town, to take their holidays simultaneously, an arrangement which is very important to families which may have father, son and mother working in all three.

The possible dates for 1962 are still under consideration. Meanwhile the proportion of holiday time spent in seaside queues and the amount of money spent on the top season rates will go on unreformed.

OMA Becomes Institute of Office Management

One of the first products of the Institute of Office Management, the new style and title of the Office Management Association, will be the first three of a series of ten film strips on computers in business.

The new Institute is starting off with divisions for the specialist branches of office management—computer application to office procedure and supervision, organisation and methods, communications and others.

An information service is to be developed and the library expanded. Mr. G. J. Mills, the chairman of the Institute's council, has emphasised that this is not only a change of name. The newly named body is to make a serious drive on tightening up standards of office efficiency in British industry and commerce.

Case Studies in Management Courses

One of the most potent weapons in the armoury of management training is the case study.

Just how the case study should be conducted and generally brought alive is the subject of more than one opinion. Some recent work at the Northampton College of Advanced Technology, London, is probably unique in this field.

Members of the South London branch of the British Institute of Management, who are cooperating with management studies lecturers at the Northampton College, have been appearing as characters in case study exercises. The exercises have succeeded in making the studies more realistic, in bringing out subtle issues of verbal communication and in giving experience in interviews and conversations, integral parts of the manager's daily round.

The BIM's South London group has found two specific reactions to case studies. Where a specific management problem, perhaps a direct conflict of decisions, was apparent, the discussion would confine itself to the evident problem and to suggesting a way out.

When the case involved more intangible problems and a deeper analysis, the more limited focus was broadened to more general thought on the personalities concerned and on the effect of the working background.

Definite difficulties exist in the cases available for study as well as over the writing up of the material and the way the cases are to be best used. A weekend conference on the research necessary for the preparation and use of case studies is to be held in October by the BIM's South London committee.

The conference will be held at the British European Airways staff college, East Burnham, near Slough, Buckinghamshire.

Engineering Unions' Shopping List

The list of items on the agenda of the Confederation of Shipbuilding and Engineering Unions for negotiation with the employers is now quite comprehensive.

First and foremost, behind the Confederation's decision at York to ask the shipbuilding and engineering industries' employers for wage increases for their three million workers lies the approval of the unions' summer conferences, including the sheet metal workers and coppersmiths who went so far as to talk of strike action.

The difficult subject of differentials is not far away, and the Confederation is to seek a pay increase for the craftsmen in the gas industry.

Following the acceptance of the employers' offer of increases of between 4*s* and 15*s* to 16*s* a week for the 16,000 apprentices in shipbuilding and ship-repairing, the union leaders are now seeking a rapid settlement of the claim for the 100,000 apprentices in the engineering industries.

There is also the question of night work in the car firms. The rank and file have carried the day, and the unions' negotiators will be asking for a general system of four normal nights and a short Friday night.

The Water Boards will be asked to grant their employees an additional week of paid holiday.

Success Achieved in Resettlement of Regulars

Between July, 1957, and the end of March this year, 16,000 officers and 200,000 other ranks left the Forces. Three-quarters of the officers and some 40 per cent of the other ranks asked the assistance of Ministry of Labour machinery in finding jobs.

Now, the work of resettling those who were compelled to leave the Forces by the premature retirement policy has reached the point where it has proved possible to wind up the Advisory Board on the Resettlement of ex-Regulars, of which Sir Frederick Hooper was chairman.

Before the early retirements began, there were 641 officers and 991 other ranks registered with the Ministry as unemployed. At the end of this March, those figures were 736 officers and 1,209 other ranks.

The chairman and the members of the Board, which includes Sir William McFadzean, of the Federation of British Industries and BICC, have all offered to hold themselves available for advice to the Minister on future resettlement problems that may need to be solved.

The Resettlement Service and the committees in Scotland, Wales and the regions will continue to function and the machinery maintained by the voluntary organisations and the Ministry will still do its work.

The special courses, including the six-week business re-orientation course, attended by 850 regulars in 1959, are still operating. Among these are the Ministry of Labour's technical staff college at Letchworth for warrant officers and others who are likely supervisors and the 14 Government training centres for instruction after release.

Operational Research Apprentices

The urgent importance of improving efficiency in industrial operations underlines the value of the specialised training in operational research which the British Iron and Steel Research Association is to undertake in a graduate apprentice scheme.

It is intended that the two-year course shall cover not only the techniques of operational research but its application to particular industrial problems.

The course will lead up to an examination for the Diploma in Operational Research, set up by the London School of Economics. The training course will be a combination of direct experience of steel industry problems through the BISRA operational research department and of a formal course which has been arranged with the LSE.

The apprenticeship carries a salary of £700 a year, plus £25 for every year above 21, and is open to those with a good degree in pure or applied science, mathematics or statistics.

High Strength Bolts Have Come to Stay

High strength bolts are now widely used for site connections in cranes, bridges and framed buildings. They mean quicker and quieter erection, and a greater fatigue strength of the connection.

By Howard Martin

Guest Keen and Nettlefolds (Midlands) Limited

It is very doubtful if any single change in structural engineering practice has created so much interest, been accepted so rapidly or opened up so many interesting possibilities as high strength bolting of connections. This type of connection has been in general use in this country for about six years and in the United States and Canada for about twelve years. In the United States and Canada it is now the preferred method of site fastening and the same will soon apply in Great Britain and in most other countries.

Perhaps the earliest recorded experiments using the high strength principle were those undertaken by Professor Batho and his colleagues at Birmingham University and published by the Department of Scientific and Industrial Research in 1934. However, in continued research and practical application of these ideas, the Americans were ahead of us. Now, in this country, high strength bolting is being used for site connections in all types of structures, including bridges, cranes and frame buildings. Fig. 1 is a heavy connection made with high strength friction grip bolts on the roof steelwork of the CEGB's Uskmouth "B" power station; the steelwork was fabricated by Braithwaite and Company Structural Limited, and the consulting engineers L. G. Mouchel and Partners of London.

BOLTS VERSUS RIVETS

Black bolts have been used in structures for many years, but only in unimportant connections —the main fastening has been the rivet or the "turned barrel bolt." It has been known for a long time that the working loads on the majority of riveted joints had been resisted by frictional forces rather than by shear on the rivets. This frictional force is created by the hot driven rivet contracting when cool and exerting a strong clamping force on the members. This shrinkage also often means that the rivet does not completely fill the hole. Nevertheless, the design of a riveted joint is based on shear and bearing. Turned barrel bolts are used in close tolerance reamed holes, consequently they are always in bearing.

The high strength bolt is a four-part fastening —a bolt, nut and two hardened washers—each complementary to the other (see BS 3139). Apart from the tensile strength there is nothing special about either the bolt or the nut. The hardened washers are used to prevent the bolt head and nut embedding into the softer structural steel and to give a better surface for tightening. The basic principle of the high strength joint is to produce a sufficiently high clamping force on the adjoining structural members to enable the load to be transferred from one member to another by friction, thus eliminating shear stresses on the fastenings (see Fig. 2). In rivets the clamping force will vary with the thickness of the grip, but with bolts it is constant for all grips. The result is that bolts are subjected to tensile stresses only, whereas riveted joints are subjected at the same time to shear and bearing. In such a joint the bolt will neither be stressed in shear nor in bearing because the principle stress is the axial bolt load. This means that a fluctuating external load on the joint will create very little, if any, effect on the initial bolt stress. Because high strength bolts are tightened up to such a high level there is a tendency to insulate them against impact, the energy being absorbed by the surrounding steelwork rather than the bolts themselves.

TYPICAL QUESTIONS

The advantages of high strength bolts over rivets and turned barrel bolts are many. There is a more uniform stress distribution which means greater fatigue strength. High strength bolts are used in clearance holes, therefore erection is much faster and can be carried out by a small team requiring little training. Less scaffolding is required, quieter erection is possible, and they have been proved more economical for site erection. This system can also be used with equally good results in place of site welding.

At present high strength bolts are recognised by BS 449 and the following clause regarding design is included.

"Pending the preparation of a British Standard on the general use of high strength friction grip bolts for steel structures, the use of these bolts is not precluded on the basis of a replacement of one bolt of the same nominal diameter when the rivet is considered to be a site driven rivet having a cross-sectional area equal to the gross area of the rivet hole, provided that the bolts are tightened up to not less than 90 per cent of the minimum proof load."

In view of the extra strength of the bolt joint many designers feel that there should be some relaxation of this rule and at present a British Standards Institution committee is considering design procedure and field practice. It is hoped that the committee's findings will soon be published so that there shall be some official guidance which will enable designers to depart from the "bolt for rivet" replacement principle.

One common question is "what would happen if the loads on the structure became excessive enough to bring the bolts into shear." Tests which have been taken prove that the load to produce slip into bearing would have to be far more for bolts than for rivets, i.e., much more than the allowable working load, and that even if the bolts did go into bearing they would carry more than 50 per cent more load than rivets, before failure.

It is often asked "what happens if the nuts come loose." Numerous tests have shown that, if the nut is properly tightened in accordance with the instructions given, they will not come loose even when subjected to shock, impact or severe vibration. There have been many cases where bolts have been used to replace rivets which were constantly breaking or working loose and after examination over a series of years it has been proved that the bolts have stayed tight, with the nuts also in place.

Structural joints in direct tension are few but there are many where combined shear and bending stresses are quite common. Quite a number of tests are being taken on this type of joint at present. The evidence available suggests that if a connection is either completely or partially tension loaded then it will be superior to the riveted joint. It is frequently thought that an external tension load will be added to any tension in the bolt, but again it has been proved that until the external tensile load exceeds the tension load induced in the bolt, the bolt load will remain practically unchanged.

A bolted joint is also stronger in fatigue. Fatigue in a bolted joint must be examined two ways: fatigue of bolt and fatigue of the bolted material. As has been explained above, the initial bolt tension will remain practically constant unless the external load exceeds the load in the bolt and no designer would permit this to happen. It will therefore be seen that there will be little if any stress variation in the bolt and without stress variation there can be no fatigue failure. What of joint fatigue? Again tests have proved that the fatigue strength of friction grip joints, properly tightened, are about 25 per cent stronger than a riveted joint, and this is especially true on joints subjected to repeated loads. In dynamically loaded joints, the fatigue strength at two million cycles is greater than the allowable working stress permitted statically. This means that joint fatigue in bolted structures can be ignored completely.

High strength bolts have been used in America, Canada and Norway where temperatures are as low as −60° C in the winter. Many of these

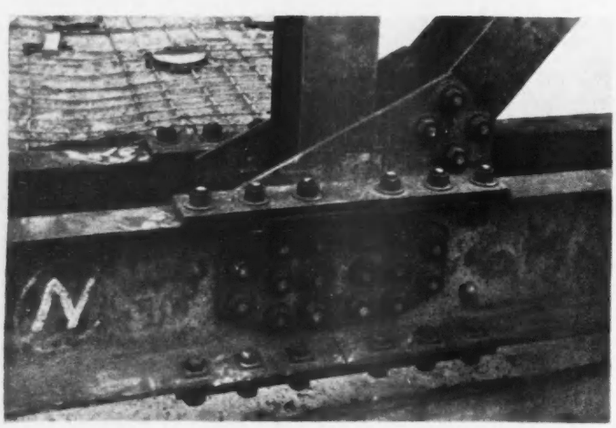

Fig. 1 (left) Heavy duty connection made with high strength friction grip bolts.

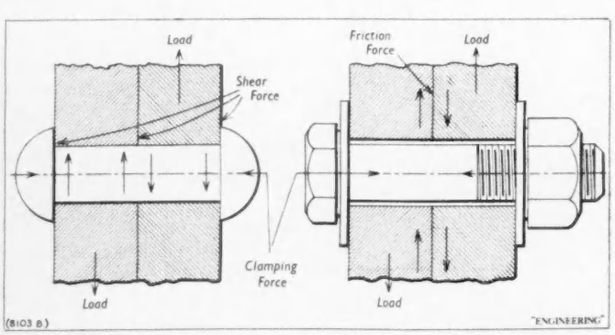

Fig. 2 (above) Basic differences between the shear stresses of the riveted joint and the friction grip of the bolted joint.

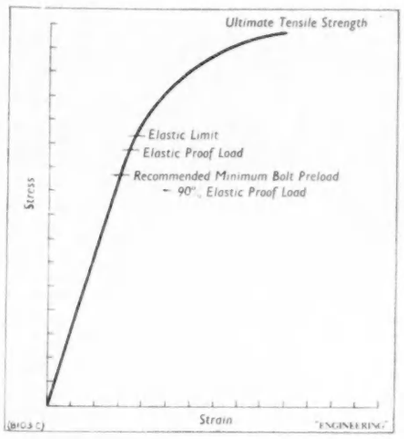

Fig. 3 Typical stress-strain curve for A-325 friction bolt.

joints have been inspected over several years and have been found to be perfectly satisfactory.

TIGHTENING

What is meant by a "properly tightened joint"? It means tightening up to an absolute minimum of 85 per cent of the yield strength of the bolt or 90 per cent of the elastic proof load. There is no maximum. Fig. 3 shows a typical stress-strain curve. It will be seen that the plot is quite straight up to the elastic limit and that there is then a gentle curve (without any clearly defined yield point) up to the ultimate tensile strength of the bolt which is some 70 per cent higher than the recommended minimum preload. It is now accepted practice to tighten bolts well above their yield point into the plastic state. Many engineers are afraid of this and think that immediately the bolt is stressed into the plastic range it is no longer able to carry its load. If the stress/strain curve is re-examined it will be seen that there is no place where (as with a mild steel bolt) there is a sudden drop in the curve with an increase of strain. It has been demonstrated time and time again that bolts stressed into the plastic state perform just as well as those stressed only in the elastic range. Certainly if the bolt is stressed into the plastic state there will be some relaxation of load, whereas there is little or no relaxation of tension in a bolt loaded only into the elastic range. However, the greater part of this relaxation takes place in a few hours after tightening. This is due to the plastic strain which occurs during the initial loading and the creep during relaxation causing the material to strain harden thus increasing the proof stresses and the ultimate tensile strength. Therefore the residual load in the "plastic" bolt must always be more than the bolt stressed elastically.

During the last two years two methods of tightening have become very popular and are used extensively. Both can be recommended as good practice and are as follows:

(1) **Part Turn Tightening.**—This method consists of a preliminary tightening (usually with a podger spanner) and it is essential at this stage that the surfaces of the joint are brought into close contact. After completion of preliminary tightening of all nuts in a joint, paint marks are made on each nut and the protruding threads to mark their respective position. Each nut is then turned $\frac{1}{2}$ or $\frac{3}{4}$ of a turn, as detailed in the table below:—

Final Tightening of Nuts

Diameter of bolt, in	Grip length, in		Grip length, in	
$\frac{5}{8}$	up to $4\frac{1}{2}$	$\frac{1}{2}$ Turn	—	$\frac{3}{4}$ Turn
$\frac{3}{4}$	"		$4\frac{3}{4}$ to $8\frac{1}{2}$	
$\frac{7}{8}$	"		$4\frac{3}{4}$ to 11	
1	up to $6\frac{1}{2}$		7 to 14	
$1\frac{1}{8}$	"		"	
$1\frac{1}{4}$	"		"	

A power-operated impact wrench is usually used for the final tightening, and with a little practice this can be used for both parts of the tightening sequence.

(2) **Torshear Bolts.**—This is a special bolt for which patent application has been made (Fig. 4). It is a standard high strength bolt on which the threads are extended beyond the but and a groove of a calculated depth is formed in the extension. A special compressed air-operated Torshear tool is also available that grips the bolt extension and applies anti-clockwise torque, while the nut is rotated clockwise through a differential gear. A balance of torque is maintained between the two until the increasing torsional stress on the bolt exceeds the calculated maximum torsional shear strength of the reduced area and this section shears, so limiting any further tightening of the nut. The sheared end is then ejected by putting the tool into reverse.

This method leaves no control with the operator, the onus for correct loading being transferred from the wrench to the bolt. The tension obtained is about 90 per cent of the yield strength of the bolt actually being used. This method involves no wrench calibration; under or over-tightening is eliminated; it requires only one-man operation; is quick (about 10 to 12 seconds); and inspection afterwards is merely visual. A hand operated Torshear tool is also available.

FUTURE DEVELOPMENTS

The future may perhaps bring the use of fewer, but stronger, tensile bolts (such bolts from steel to BS 1768 Code symbol "V" are already available for special applications) but it is necessary to proceed with care. High strength bolts hold by friction rather than direct shear, and the real basis of using one high strength bolt for one rivet (especially in dynamic structures where the joint makes a complete reversal and fatigue strength is critical) is in order to develop sufficient friction. A very large reduction of bolts, even if they are of higher tensile strength, may affect the clamping area and thus the friction developed; adequate tests, therefore, must be made first before the number of bolts is reduced too far. Further investigations by research laboratories, including the author's, goes on and other developments may be expected in the not too distant future.

Fig. 4 Torshear bolt (right) before tightening and (left) after tightening with the freed extension which is sheared off when the requisite load has been put into the bolt.

It is not possible in such a short article to do more than give a summary of the advantages of high strength bolting but a list of important contributions to present knowledge is appended where further information can be obtained.

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Progress on the Cross-Channel Power Link

Interchange of electrical power between Great Britain and France is expected to begin towards the end of 1961. The work on the power link was begun earlier this year and now the contract, worth £610,000, has been let by the Central Electricity Generating Board to Associated Electrical Industries Limited and British Insulated Callender's Cables Limited for the British end of the power cable. The remainder is the responsibility of Electricité de France.

As planned, the link will permit up to 160 MW to be transferred from one country's system to the others to meet peak load demands or at such times as there is a surplus or shortage of water at the French hydro-electric stations.

The connection between the 275 kV supergrid in this country and the 225 kV French network will be by a direct current circuit of 160 MW, with allowance for a 20 per cent overload for isolated periods of 30 minutes. The d.c. transmission will operate at 200 kV with a normal full load current of 800 amps—the heaviest d.c. load yet taken under water.

The Channel connection will consist of two 30 mile submarine cables running from near Dungeness (Kent) to Le Portel, a suburb of Boulogne, with a 3 to 4 mile land cable at each end. The converter stations, to rectify from a.c. to d.c. and to invert back from d.c. to a.c., are under construction at Lydd and at Echinghen. Along the British half of the route the cable depth will reach a maximum of 20 fathoms, against 30 fathoms in the French half.

The two cables have to be laid close enough together that the magnetic compass deflection caused by the current is not in excess of 2°. From the British end they will be laid by the CEGB's converted collier MV Dame Caroline Haslett; this vessel was temporarily converted for trial laying operations last year and now the Generating Board are negotiating with AEI for the additional alterations. She will aso be used for repairing the cables, should faults develop, by jointing-in new lengths.

Stranded copper wire with a cross-section of 0·525 sq. in and lapped with an electrostatic screen will be used for the submarine cables. The solid impregnated paper insulation, also lapped with an electrostatic screen, is sheathed with a lead alloy which is protected against corrosion by vulcanised rubber tapes. Armouring is a single layer of galvanised steel wires with beddings and servings. The cables weigh about 39 lb per yard in air and 28 lb in sea water.

A larger conductor size will be used for the land cables because of the lower heat dissipating properties of soil compared with water. In loam a copper section of 0·6 sq. in will be used, but where shingle is encountered this will be stepped up to 0·925 sq. in.

A Case Study in Planned Electrification

Every country striving to raise its standard of living must produce more electricity. Underdeveloped areas have their special problems: the need for full employment overrides straight economics.

LACKING coal and oil locally Madras State in India had to rely on water power for balanced economic development. Until about 1908 its power generation was confined to a few tiny hydroelectric installations on tea estates, and to the small water power plant in the Niligiris. The first public electricity supply in the state was started in Madras City in 1909 by the Madras Electric Supply Corporation. Real progress dates, however, from 1925 when the local Government initiated the policy of deliberate development of the power resources by the state. In furtherance of this policy the first hydroelectric project—the Pykara scheme—was taken up in 1929, and the station was commissioned in June, 1937; the Papanasam power house followed in April, 1944. The first thermal station to be built by the State Electricity Department was opened at Madurai early in 1951. The first five year plan was confined to the construction of a new power house at Moyar and extensions to the existing stations at Pykara, Papanasam, Madurai and Madras. Installed generating capacity increased by approximately 65 per cent from 156,000 kW to 256,700 kW. The third stage extension at Madras was completed in April, 1958, and the Periyar hydroelectric scheme the following October.

Power projects of Madras State included in the second five year plan, as originally approved by the Planning Commission, were computed to cost Rs. 60·03 crores (one crore = £750,000), but an economy cut reduced this sum to Rs. 53·25 crores. The eventual outlay is, however, reckoned to total Rs. 71·31 crores, or 38 per cent of the aggregate expenditure for the state. On completion, these schemes will more than double the installed generating capacity, lengths of the lines and the number of towns and villages electrified. The Madras plant extensions (under the third stage), a 30,000 kW set with two 150,000 lb per hr boilers were completed in April, 1958. The first unit of the Periyar hydroelectric scheme was completed in October of the same year, the second in February and the third in May, 1959, adding 105,000 kW installed generating capacity to the grid. Plant No. 1 of the Kundah project was commissioned last March. Thus, during the first four years of the second plan period 155,000 kW has been added, and the balance of 160,000 kW will follow during the final year (1960-61). The Madras power grid covers all the districts of the state, and comprises five hydroelectric power stations: Pykara 70,200 kW, Moyar 36,000 kW, Mettur 40,000 kW, Papanasam 28,000 kW, and Periyar 105,000 kW. There are, in addition, two thermal power stations: Madras 98,500 kW, and Madurai 14,000 kW. The total is thus 391,700 kW. There are 13,900 miles of HT transmission lines of voltages varying from 11,000 to 110,000; 99,000 miles of LT distribution lines, 76 EHT and 70 HT substations, and 8,800 distribution stations. The Madras grid is serving electricity to 6·7 lakh consumers—80 per cent of them are served direct by the board, and the rest through 5 municipal licensees and 8 private licensees. The aggregate peaks of the systems during the year was 410,000 kW, while the coincident peak of the grid was 336,000 kW. Power generated during the year will be 1,900 million units, of which 76 per cent will be from water power and the balance from coal. Total capital investment to the end of March, 1959, was Rs. 119 crores, and annual gross revenue during the year exceeded Rs. 15 crores. Including the transmission lines under the Kundah and Periyar hydroelectric schemes, an additional 8,200 miles of EHT and HT lines, and 12,000 miles of LT lines will be constructed during the second plan period. Of these, 6,400 miles of EHT and HT lines and 10,900 milse of LT lines have already been built in the first four years of the plan. A major forward step in respect of transmission during the second plan period is the first 230 kV line in the state from Kundah to Madras, a distance of 300 miles, completed early in 1960.

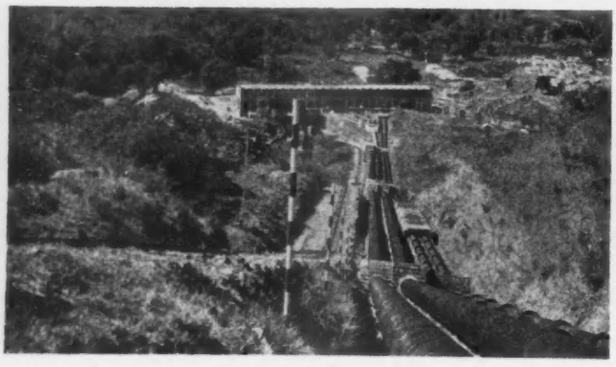
Madras State continues to maintain its lead in the field of rural electrification with over 9,100 towns, villages and hamlets electrified by last February. During the full second plan period it is expected that some 6,200 additional villages and hamlets will enjoy the benefits of electricity. Nearly 32,440 pump sets were operating on electricity at the end of 1955-56. Last March nearly 98,000 pump sets were so functioning. Demand for power in this State is both widespread and insistent. Several new industries are planned, using power from the grid. To meet this mounting demand an ambitious programme has been drawn up for execution in the third plan period (1961-66). The scheme, estimated to cost Rs. 133 crores, will more than double the present installed capacity. Eight thousand more villages in the interior will have electricity, apart from 75,000 agricultural pump sets. A load forecast was prepared by the working group set up by the Madras Government, taking into account the licences for industries already issued, and the schemes recommended in the report of the Techno-Economic Survey of the state conducted by the National Council of Applied Economic Research. In the light of their findings power demand is reckoned to rise to 891,000 kW at the end of the present plan period, and to 1,448,000 kW at the close of the third plan period. Projects drawn up to meet this power growth during 1961-66 are computed to cost Rs. 133·21 crores (including a foreign exchange component of Rs. 43·6 crores), compared with the outlay of around Rs. 71·45 crores for the second, and Rs. 30·68 crores for the first plan.

Turning to individual undertakings: the Mettur Tunnel scheme is calculated to utilise the irrigation discharge of 20,000 cusecs at Mettur Dam to develop seasonal power for seven months from July to January every year. During this period the storages in the Kundah and Pykara basins will be conserved to the extent necessary for utilisation in dry, summer months for augmenting the Mettur power. This project is to be developed in two stages, the first covering construction of a power house with an installed capacity of 100 MW in two units. On completion the first stage will add to the grid an energy potential of 385 million units.

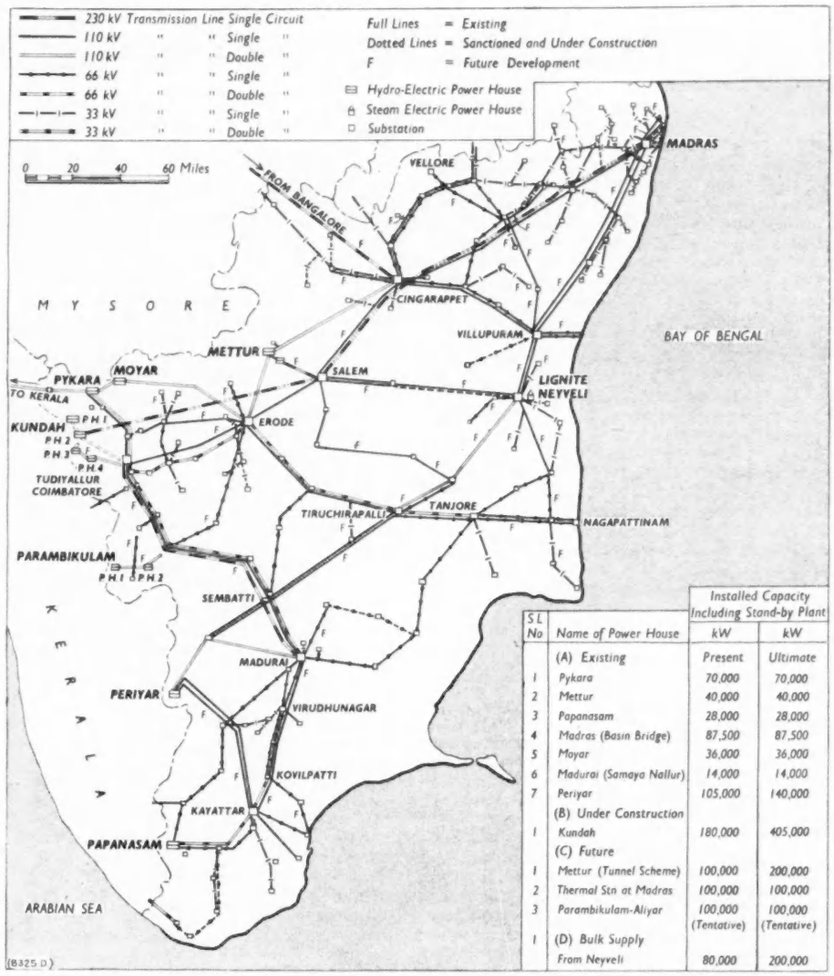
A total fall of 5,359 ft is available for power generation at Kundah, of which the present phase

Power Development of the Madras Grid

	At the beginning of 1st plan 31.3.1951	At the end of 1st plan 31.3.1956	At the end of 2nd plan 31.3.1961
Generation:—			
Installed generating capacity, MW	156	256	571
Aggregate demand, MV	130	208	560
Units generated, millions	630	1,053	2,500
Transmission:—			
Length of HT lines, miles	4,355	7,343	15,500
Length of LT lines, miles	3,580	8,128	20,000
Distribution:—			
No. of consumers, laks	2·5	4·26	8
Substations including distribution transformers	1,647	3,862	10,150
Rural electrification:—			
No. of villages electrified	1,613	3,320	10,000
No. of agricultural pumps connected	14,373	32,440	100,000
Finance:—			
Capital outlay, Rs. crores	30·96	54·01	125·34
Gross revenue, Rs. crores	3·37	7·03	18·42



Four of the five hydroelectric power stations are shown here: (left) Pykara 70,200 kW, (right) Mettur 40,000 kW, ...



Sl No	Name of Power House	Installed Capacity Including Stand-by Plant kW Present	kW Ultimate
	(A) Existing		
1	Pykara	70,000	70,000
2	Mettur	40,000	40,000
3	Papanasam	28,000	28,000
4	Madras (Basin Bridge)	87,500	87,500
5	Moyar	36,000	36,000
6	Madurai (Samaya Nallur)	14,000	14,000
7	Periyar	105,000	140,000
	(B) Under Construction		
1	Kundah	180,000	405,000
	(C) Future		
1	Mettur (Tunnel Scheme)	100,000	200,000
2	Thermal Stn at Madras	100,000	100,000
3	Parambikulam-Aliyar	100,000 (Tentative)	100,000 (Tentative)
1	(D) Bulk Supply From Neyveli	80,000	200,000

under construction makes use of a drop of 3,647 ft. The third stage of extensions is to utilise the remaining 1,712 ft, collecting the water of adjacent rivers and streams *en route*. The fall is to be developed in two more power stations, the third power station with an installed capacity of 120,000 kW in three units, and the fourth of 50,000 kW in two units. In addition, a third unit at Plant No. 1 and a fifth unit at Plant No. 2, besides an auxiliary station to utilise the fall between Upper Bhavani and Avalanche reservoirs with an installed capacity of 15,000 kW are also envisaged. The aggregate installed capacity that will be added during this stage is 240,000 kW. On completion the Kundah hydroelectric scheme will have a capacity of 420,000 kW, and its potential will be 1,803 million kWh per annum

Thirdly, the Parambikulam project calls for the construction of two power stations, one in Parambikulam valley utilising the waters diverted from Nirar and the surplus waters available from the Sholayar power house, and the other at Sarkarpatty making use of the tail race waters of the first station and regulated flows from the Parambikulam, Tunakadu and Tekkadi rivers. The first power station, Sholayar, will have an installed capacity of 70,000 kW in two units, and Sarkarpatty station, a single generating unit of 25,000 kW. Fourthly, the Periyar second stage extensions provide for the installation of one more 35,000 kW unit to step up installed capacity from 105,000 kW to 140,000 kW.

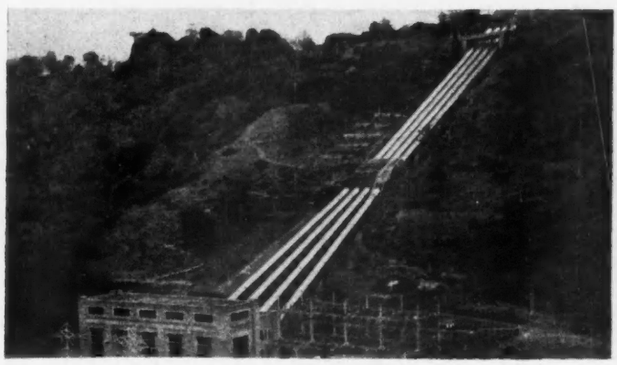
At present the Madras State has only two thermal power stations, one at Madras and the other at Samayanallur (Madurai). Coal is obtained from distant Bengal and Bihar, and there is considerable difficulty in the transportation of this solid fuel apart from its continually rising cost Local power development in the earlier years was mainly confined to the harnessing of water power since no coal or lignite deposits were known to exist With the present price of coal the cost of thermal power in the State is virtually thrice that of hydroelectric power. Now that lignite in commercial quantities has been located in Neyveli in South Arcot district it is proposed to utilise it for power generation. The Neyveli Lignite Corporation (NLC) have agreed to give power to the amount of 159,000 kW after the second plan period. The NLC have been requested to install additional generating sets to the extent of 200,000 kW and release this power in full to the Madras State; as an alternative, the corporation is to supply enough lignite for a separate thermal station to be started as a part of the Madras grid.

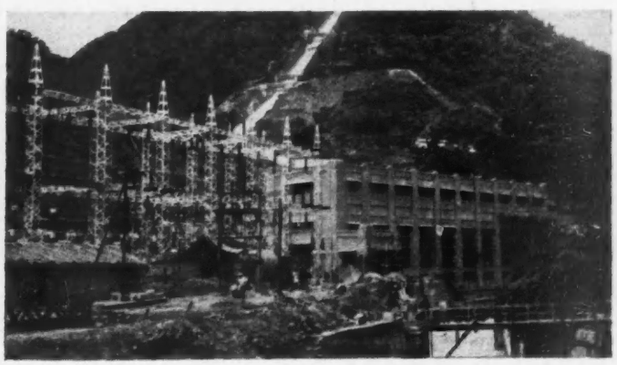
The super-grid will necessitate the construction of a 220 kV d.c. line from Neyveli to Singarapet, Neyveli to Madurai, and a 220 kV a.c. line from Tudiyalur to Kundah. It is also proposed to interlink Madras and Mysore, and Madras and Kerala, by 220 kV transmission lines. The interconnection between Madras and Mysore, and a similar link between Madras and Kerala, is under consideration. In this connection Singarapet and Madurai will form the linking points with Bangalore (Mysore State) and Peermedu (Kerala State) respectively.

The installed capacity of hydroelectric stations by the end of 1965-66 will be 929,000 kW with an annual energy potential of 4,285 million kWh. Total energy from the grid will be 7,280 million kWh per annum, including that from the thermal power station and the power to be purchased from the Neyveli Lignite Corporation. The total capacity of the grid will be 1,400,000 kW, including the 359,000 kW to be obtained from the NLC. The formation of 220 kV super-grid is under consideration.

While the capital costs of hydroelectric projects are high and maintenance costs low, in the case of thermal plants it is vice versa. It is to be hoped that the ideal combination of base and peak power projects and the evolution of tariffs based on utility values will soon come into effect.

Only such a flexible combination can overcome the difficulties of seasonal loads occuring in dry conditions when the water position in rivers and ponds is most critical and strained. In the past, power projects were quite properly treated as economic undertakings, concerned primarily with their own individual profits and losses. Under national planning, however, they are national utilities, the economics of which are different. Power cuts would be appropriate under purely economic schemes, but in a different context the resultant loss to producers and through them to the State in the form of slack in economic activity, has to be considered.





. . . . . *(left) Papanasam 28,000 kW, and (right) Periyar 105,000 kW. They feed the Madras power grid.*

What Attracts Capital to Engineering?

Most engineering firms consider expansion from time to time. What kinds of product, plant or company are most likely to attract the necessary capital? How is expansion financed? Much depends on a record of good management.

By G. E. Tewson

WHAT kinds of engineering attract capital? The answer can be quickly given—those who want it, who know how much they want, who know where to look for it, how to ask for it and can show that they can profitably use it. Giving a straight answer to a straight question takes the engineer only to the fringes of the problem of finance. It is here that the mystery of money really begins. One now enters a world of aphorisms which sound strange to the technically trained ear.

One is told by those skilled in finding finance for clients that the less one wants the harder it is to get; and that those responsible for advancing capital to engineers seldom employ engineers to advise them.

Capital for investment is always faced with a choice of applications. From the lender's point of view it is money that is put at risk, and though your business may look a good risk to you it may look less attractive than another to an impartial outsider. On the whole, jockeys are good judges only of their own mounts.

That some kinds of engineering enterprise can obtain capital more easily than others is apparent enough. The large, well established electrical engineering concern with half a century of progress in home and export markets is likely to receive a quicker hearing than the man with a brilliant new idea which has not yet been tried commercially.

Over the last six years the bank accommodation sought by the engineering industry has increased from £138 million in the average quarter of 1954 to £318 million in February, 1960. Perhaps more significant, the proportion of bank advances to engineering over that time has gone up from 7 to 9 per cent of the total. Engineering concerns have been seeing more of their bank managers to fix up temporary finance to their mutual advantage.

LONG TERM FINANCE

Yet if one looks at the amount of long-term capital raised by the engineering industries in the capital market, that is to say where industry by tradition raises the big money to pay for plant, equipment and the new buildings to put them in, there is little sign of activity. According to the Midland Bank's figures of new capital issues to the public, iron, steel and engineering (the figures include coal which borrowed no money in this way over these years) raised £124 million in 1957 and only £37 million in 1959, of which the English Electric Company alone accounted for over £10 million. The big figure for 1957 is accounted for by the high activity of the big steel companies in the new issue market. So the picture is not one of severe decline; rather it is one of continuing absence of the engineering industries from the market. The London capital market is for the very big companies anyway and the typical engineering concern is still the small one, employing a few hundred and not tens of thousands of operatives. Where does the typical concern look for long-term finance and what credentials must it offer to get it on terms which are acceptable?

Putting aside those companies which can finance their requirements out of their own accumulated profits (and there are still many which would do it in no other way) the first questions to consider are what size of sum is wanted and what kind of professional advice to take at the outset. Lord Piercy, chairman of the Industrial and Commercial Finance Corporation Limited (which is mainly interested in making loans, not investing in the share capital of small and medium sized concerns) has said that most of inquiries to them come through companies' auditors. The experience of the ICFC is particularly relevent for it specialises in loans within the range of £5,000 to £200,000 and at the end of March, 1959, had £8·2 million or 25 per cent of its funds at risk with the engineering industries, expecially in machine tools and agricultural machinery.

Experts do not advise using short-term finance for long-term purposes. Indeed they advise specifically against it. Mr. J. R. Kinross, speaking on "Financing Industry" at a conference some time ago organised by the British Institute of Management, put these initial problems succinctly when he said there were three groups or sizes of long-term financial assistance to be considered so far as long-term capital is concerned.

There are those concerns which want a modest amount, up to £5,000. This can be a very difficult sum to arrange. Then there are those between £5,000 and £200,000 for which there are specialist organisations and then there are those over £200,000 for public issues, for investment by insurance companies and the larger investment trusts. The large majority of engineering concerns are usually in the middle group except when money is wanted for the purchase of one or two readily identifiable items of plant, a matter which is dealt with later.

In addition to the ICFC there are also a number of highly specialised corporations such as the Ship Mortgage Finance Company, Air Finance Limited and the National Research Development Corporation.

FINANCE HOUSES

Among the industrial finance companies one of the best known is the Charterhouse group. As a case in point, George H. Scholes, electrical engineers, approached Charterhouse in 1947 with the result that an investment was made. In the 10 years from 1950 the profits before tax had increased more than fivefold from under £60,000 to over £300,000. In 1955 the shares were offered to the public and are now quoted on the Manchester Stock Exchange.

Of recent years the merchant banks have taken an increasing interest in providing finance for the period required for nursing a small business through the stage of growth before it can offer its shares to the public. The big merchant banks such as Hambros Bank Limited are always on the look-out for thriving private companies with a good record to nurse along.

Whether the organisation interested in offering finance is a specialist finance corporation or a merchant bank, they are all looking for the same kinds of indication of credit-worthiness, and it is those concerns coming forward with these credentials which get finance on the best terms.

The basic criterion is not technical excellence of the products *per se*. Such concerns ask themselves and the client what are the growth prospects in the field of engineering concerned. Has the concern a wide range of customers? For example, a small die-casting business with wide contacts is a better risk than a concern making a product for only one motor-vehicle manufacturer. A concern turning out essential engineering components, come boom or depression, is a better bet than one doing a lot of jobbing work for other companies at times of high activity when capacity is scarce, only to be left in the lurch when depression comes.

Financiers examine profit and loss accounts for past years with great care, and balance sheets as well. Good, clear accounts to prove a good performance are essential. Such people want to back good managements and they ask questions about quality and loyalty of managers. They have what look like rough-and-ready formulae for judging how much money a company should be advanced: for instance, they may say that a good company with a turnover of £50,000 and an annual profit of £5,000 is worth an advance of £3,000.

It will be noticed that they are not concerned with engineering techniques and methods but as to how these are reflected in trading experience. They may not even use engineers to check the facts.

There is another field of finance which has become highly developed in recent years. This is hire purchase finance. HP has been used by industry for a long time but recent technical and economic trends have brought it increasingly to the notice of the engineering industry.

HIRE PURCHASE

Hire purchase has particular attractions today when plant and equipment are expensive to buy but highly productive to use. Hire-purchase facilities are expensive in terms of interest paid but not when set against the earning power of a well chosen machine operating at or near capacity. The hire-purchase companies like this kind of business for it provides an identifiable asset against which a contract can be made out. For the company taking up the agreement a sum of money becomes available which exactly covers the price of the equipment, which can be written off quickly (more quickly than the equipment depreciates) and which releases the company's own capital for other purposes. The investigation mentioned above showed that after advances from banks, hire purchase was the commonest source of external finance.

Hire purchase for industry is now a huge business. Total HP debt in September, 1959 (including that through retailers) was £784 million. In the December quarter of 1959 there were, according to HP Information Limited, over 137,000 contracts recorded, for industrial equipment and commercial vehicles. In the last ten years the assets of the United Dominions Trust Limited, the biggest HP financing organisation in this country and now operating overseas, increased from £16 million to no less than £119 million.

Developments have gone a stage further. Facilities for leasing equipment are becoming more general. A few weeks ago the Mercantile Credit Company Limited announced the formation of a subsidiary company to specialise in this type of facility.

The scope for obtaining assistance for purchasing specific equipment is now exceedingly wide for the creditworthy company. A concern like Stothert and Pitt will on occasion give credit facilities on purchases of large plant for from three to twelve months at interest slightly over Bank Rate on outstanding amounts. Firms like the George Cohen 600 Group have a hire fleet available and much of the road programme today depends on hired equipment.

Finance for engineering concerns thus falls into three broad categories. Short-term finance is still mainly provided by the banks when it is a question of paying the wages bill or carrying stocks. For buying specific items of equipment with a high profitability hire purchase and leasing or hiring is becoming very common and is within the reach of all reputable companies. Long term finance for general development is available from a wide variety of specialists. Today financiers are interested in finding new engineering clients. But they want clients who have a well documented history that tells a success story.

Flux Distribution

SENSATIONAL events or discoveries are absent from the 1959-60 annual report of the United Kingdom Atomic Energy Authority, just published, unless the June attenuation of the nuclear power programme is regarded as sensational. A year of steady progress is how Sir Roger Makins described the period, a year in which engineering problems have been solved or defined and the second stage of the power programme brought into clearer focus. Parallel with the work of the Authority, the first-stage power stations are rapidly taking shape, as shown in the accompanying photographs of the five construction sites, all taken recently. Next month, heavy machines of the Nuclear Power Group will start to scrape away the dirt at Dungeness to make room for the sixth station. On the other side of the Atlantic the United States Atomic Energy Commission has also been busy stock-taking. The areas of advance and the research effort applied on both sides of the Atlantic are discussed below, showing the " flux " distribution between projects.

Magnox Stations

With eight Calder Hall type reactors at full power, the Authority is rapidly accumulating operating experience. Both the availability and the power output have been increased (Atomic Review, 10 June '59) and the operating temperature will be pushed up a further 10° to around 428° F during the next year. Although the average irradiation level of Calder Hall reactor elements is only 700 MWD per tonne, in order to gather experience with longer irradiation for the civilian reactors several channels have been pushed to 1,000, and a few standard elements to 2,000 MWD per tonne. In central channel locations the performance was satisfactory, but some elements failed in colder regions owing to lack of sheath ductility. The civil fuel-sheaths will be manufactured from Magnox of finer grain-structure in order to improve ductility. The Calder Hall reactors are also used to evaluate the effect of plutonium build-up on the neutron spectrum, temperature coefficient and flux distribution, problems that will be important when fuel is irradiated to 3,000 MWD per tonne in civilian stations.

Sleeves No Longer Required

In a beautiful understatement, the report describes the effect of a positive temperature coefficient as " accentuating the tendencies to vary from the normal operating levels of the reactor." Following the realisation that plutonium build-up results in a positive temperature coefficient, the control system of civilian stations was redesigned at great cost on the basis of multi-zone control. The computer calculations were checked and verified in large experiments with a Calder Hall reactor. Wigner energy, the other troublesome aspect of the gas-cooled graphite-moderated reactor that emerged a few years ago, has been cut down to size. Experiments in material-testing reactors have shown that the rate of Wigner energy build-up decreases more rapidly than anticipated and as a consequence the Authority has decided to withdraw the recommendation that the channels should be sleeved in order to keep the graphite hot.

Control of Beryllium Canned AGR

In the Advanced Gas-cooled Reactor the adverse temperature coefficient effects will be more pronounced because the beryllium incorporated in the cans has a significant moderating contribution. Experimental and theoretical work indicates that a relatively simple control arrangement will suffice for the small Windscale AGR, but special precautions must be taken for a 500 or 600 MW(e) commercial AGR. A possible solution is to pass the reactor coolant through the moderator before the gas is used to cool the reactor channels. The re-entrant principle is incorporated in the Windscale design and the method's efficacy in overcoming control difficulties will be assessed. Mass transfer of graphite may also be significant at AGR temperatures and if canning of the moderator is to be avoided some chemical method of eliminating the migration of graphite must be found. Addition of one or two per cent carbon monoxide to the coolant produces a marked reduction in graphite loss under irradiation. Techniques for handling slightly enriched fuel are beginning to mature, and production of enriched uranium oxide pellets has begun. Beryllium manufacture is also advancing and it has been established that the demonstrated loss of ductility under irradiation is caused by the formation of helium. Re-optimisation of civilian AGR designs has resulted in a greater thermal efficiency than expected. Incorporation of better heat-transfer surfaces, improved pressure vessels and a reassessment of the steam cycle account for the advance.

New Fast Critical Facility Next Year?

Although the fast breeder concept is several stages behind the AGR, reactor studies for civilian power stations have begun in collaboration with the USAEC and Power Reactor Development Company. The first prototype may be built around 1967. As the Dounreay reactor will be used primarily for fuel testing, a new critical facility will be built for reactor physics experiments. The Authority's report confirms that the difficulties at the start-up of the Dounreay reactor were caused by oxide accumulation in the sodium-potassium alloy coolant. The oxide clean-up equipment has since been redesigned and modified.

HTGCR and Steam Generating Reactor

In preparation for the high-temperature reactor project Dragon, uranium-thorium-graphite fuel elements have been developed and tested under irradiation " to a high proportion of their design life." Only small dimensional changes were found, and the effect of high-temperature irradiation on graphite permeability and thermal conductivity were measured. The research tool Zenith, which went into operation late in 1959 (Atomic Review, 4 Sept. '59) has not proved entirely satisfactory and the heating arrangements had to be modified. The latest major UKAEA project, the steam-cooled heavy-water moderated reactor (SCHW) has advanced one step in its concept, but embarkation on the project will depend upon the availability of both technical manpower and financial resources. Sir William Cook stated that the reduction in the power programme would have no effect on the availability of manpower in this respect. Steam cooling has been advanced to the concept of steam-*generating* heavy-water moderated reactor (SGHW), essentially a heavy-water moderated boiling and superheating light-water cooled reactor. The advantage of the concept is that the light water in the core contributes to the moderating effect, reducing the size of the core, and internal evaporation eliminates the need for external heat exchangers. If funds can be found, the old DIMPLE reactor will be modified to perform the necessary reactor physics experiments.

Polyphenyl Still the Best Organic Coolant

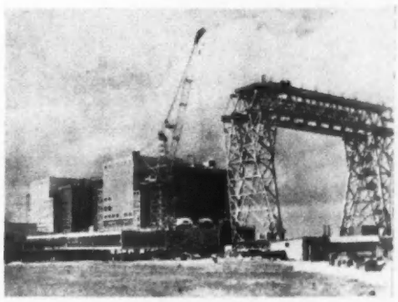
To catch up with the United States in the engineering of organic-moderated reactors, the search continues for an improved organic liquid. So far, nothing has been found, and the decrease in the rate of breakdown of commercial Santowax-R with increased polymer content turns out to be less than expected from previous work. Attempts have also been made to substitute deuterium for hydrogen in the organic liquid. Deuterated biphenyl and paraterphenyl are much more stable than the hydrogen-based compounds under electron irradiation, but only slight improvement was demonstrated in the neutron flux of Bepo. It is doubtful if the added cost of deuterated compounds could be justified on the basis of slightly increased stability.

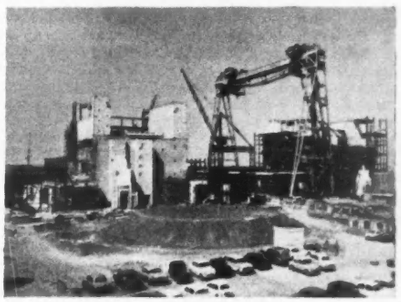
Components: Unlubricated and Gas Bearings

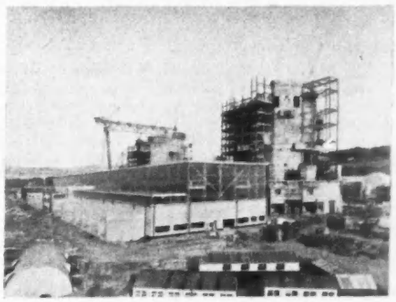
Considerable theoretical and practical experience has been accumulated with unlubricated and gas-lubricated bearings. Friction and wear in unlubricated bearings is temperature dependent, with high-chromium alloys showing the least change between ambient temperature and 400° C. Instabilities in gas bearings have been analysed: in self-acting journal bearings four modes of half-speed whirl have been distinguished and correlated with experimental results; in externally pressurised bearings, pneumatic-hammer synchronous, and half-speed whirl have been recognised. A gas-circulator using two peripheral gas-bearings for the motor and impeller has been developed in powers ranging from 7 to 60 h.p. The circulator is particularly suitable for applications with high pressure ratio and low mass flow.

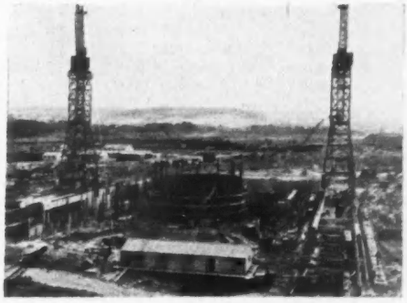
American Component Design on the Move

To aid long-term planning, the USAEC has published a summary of reactor potentialities under









First phase of the nuclear power programme taking shape: achievements (from top) at Bradwell, Berkeley, Hinkley Point, Hunterston and Trawsfynydd. An artist's impression of the Dungeness station appears on the next page.

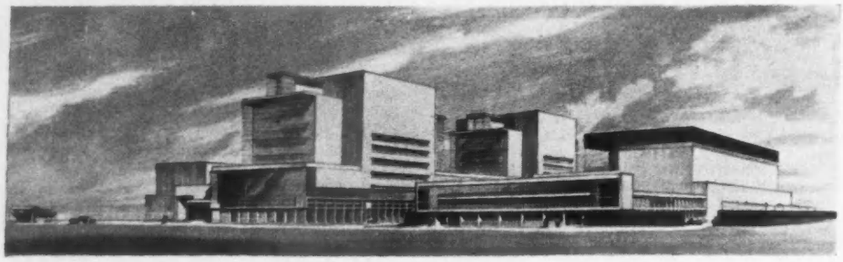
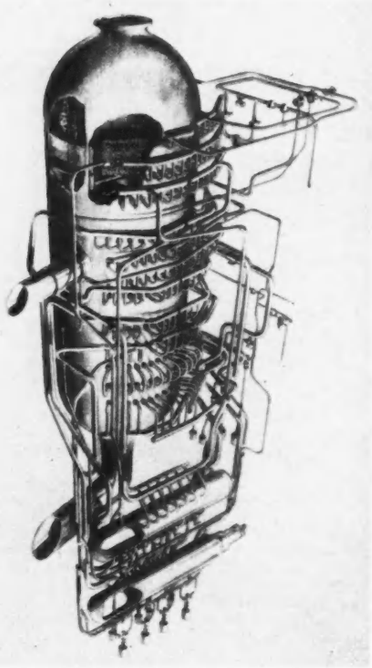


Fig. 1 (above) Artist's impression of the 550 MW Dungeness power station. Construction will start in August for completion in 1964.

Fig. 2 (below) One of eight steam raising units for Dungeness.



the title "Economic Potential and Development Program as of 1959" (TID-8517). The main lines of advance, summarised below, are in fuel element design, control, coolant circulators, and vapour containment, in addition to improvements peculiar to individual reactor types.

Self Coring of Fuel Elements

Uranium oxide has appreciable vapour pressure at reactor temperatures—well below the oxide's melting point—and the sublimation and diffusion of fuel from the centre of elements results in formation of a hollow core. It is now believed that self-coring is not a serious limitation and the rating of elements may be increased to 20 kW per ft. Collapsible cladding is developed (as opposed to "free standing" cans) which will reduce the cladding thickness of PWR fuel elements to 0·012 in. The current targets for fuel burnup are 50,000 to 60,000 MWD per tonne for pressurised water, and 20,000 to 30,000 MWD per tonne for boiling-water reactors. Sodium-cooled reactors derive no benefit from oxide fuel the conductivity of which is lower than that of the sodium coolant, and attention is now directed at uranium monocarbide. Organic-moderated reactors are "heat transfer limited" and cladding materials with better heat-transfer properties than stainless steel are sought. Zirconium is incompatible with the organic liquid, so that sintered-aluminium alloys are being developed as a replacement. Paste fuels and clad elements with gaseous fission product vents are being perfected for fast breeder reactors to reduce fabrication costs.

Improved Control

The very high burnup contemplated for water-reactor fuel makes it essential to devise control rods with comparable lifetime. Attention is now directed towards neutron rectifiers, movable fuel sections, burnable and liquid poisons, variable moderator level or variable moderator mixtures, and variable core-section enrichment. Important improvements are also necessary in the design of control-rod drives both from the viewpoint of reliability and sensitivity.

Coolant Circulators

The cost of coolant circulators represents approximately 7 per cent of the capital cost in water reactors. The high cost is caused by the requirement of special pump materials and the expensive "canned motor" design presently employed. Mechanical shaft seals or frozen seals would reduce the capital investment considerably. For boiling-water reactors a low-head pump suitable for operation with 10 ft or less of suction head would permit significant economies in plant layout, at present incorporating 30 ft risers and downcomers above the pumps. For sodium-cooled reactors a pump is being developed with combines the advantages of mechanical and electromagnetic pumping methods. The new design uses magnetic fields which are rotated mechanically. The pump has no impeller immersed in molten metal (the objection against mechanical pumps), and can be removed for maintenance without the need for cutting the line (the objection against electromagnetic pumps). Although the efficiency is limited to less than 44 per cent, the pump offers reduced first cost.

"Burp" Containment and Vapour Suppression

It is hoped that the present rigid containment requirements will be relaxed as experience is gained with water reactors. In the meantime two methods offer reduced costs. The so called "burp" containment approach would permit free escape of steam following the failure of a pressurised or boiling water reactor until the pressure is reduced to a predetermined low value. It is believed that only an insignificant amount of radioactivity would be released with the initial burst of steam, while the bulk of fission products from the melted core would be retained. The other method for reducing the pressure rise is vapour suppression by means of free water inside the containment vessel. (Atomic Review 27 May '60, 18 Sept., '59). Field trials are proposed for both methods.

Notes and News

IAEA Programme for 1961

The main item being considered by the Board of Governors of the International Atomic Energy Agency at its series of meetings which began on 14 June in Vienna are the Agency's work programme and budget for 1961. The General Conference at its last session also requested the Board to submit special reports on the economics of nuclear power and on the Agency's activities in promoting the development of nuclear power, and the director general has submitted for the board's consideration detailed drafts on these subjects. A number of requests for technical assistance in the form of services of experts and the supply of equipment have been submitted by the director general for the board's consideration. The cost of the projects that the director general has recommended for approval amounts to $320,000. At its April meetings the board approved projects at a cost of $279,000. At its last series of meetings the board decided to consider further in June a request by the United Arab Republic and any other similar requests for Agency assistance in establishing regional centres for training in the applications of radioisotopes. At that time an Agency mission was visiting countries in Africa and the Middle East to collect first-hand information on needs and possibilities for such centres. The director general's report on the mission, which visited eight countries, is now before the board. The United Arab Republic has also submitted additional information in connection with its request for the establishment in Cairo under IAEA auspices of a Middle East regional radioisotope centre for the Arab countries. The Board of Governors will also be asked to approve for submission to the General Conference a relationship agreement between the Agency and the European Nuclear Energy Agency (ENEA) of the Organisation for European Economic Cooperation (OEEC). The General Conference is scheduled to meet in the latter part of September.

Four Stations by TNPG

With 1,225 MW(e) nuclear capacity under contract, the Nuclear Power Group (TNPG) has jumped into the lead among the world's nuclear contractors. After Berkeley, Bradwell and Latina, the group last week secured the contract for Dungeness. As expected, the design is based on earlier stations but marked increases in coolant pressure were necessary to raise the rating to the record 550 MW(e). Over the last three CEGB contracts the pressure rose from 185 lb per sq. in (Hinkley Point), through 240 lb per sq. in (Trawsfynydd) to 283 lb per sq. in at Dungeness. The graphite core will be prism shaped, made up of two types of bricks: large octagonals forming the coolant channels, with small square keys. The overall station efficiency will be almost 33 per cent. Completion date for the station is 1965.

Dungeness Technical Data

Net electrical output	550 MW
Heat output per reactor	835 MW
Efficiency	32·9 per cent
Reactor gas bulk outlet temperature	410° C, 770° F
Reactor gas inlet temperature	250° C, 482° F
Nominal max. can surface temperature	442° C, 828° F
Nominal max. uranium temperature	563° C, 1,045° F
HP steam pressure at blower TSV	1,410 lb per sq. in
HP steam temperature at blower TSV	392° C, 738° F
LP steam pressure at main TSV	550 lb per sq. in
LP steam temperature at main TSV	390° C, 736° F
Feedwater temperature	180° C, 356° F
Fuel:	
Number of fuel channels per reactor	3,876
Number of elements per channel	7
Overall length of fuel element	41·7 in
Dimension of uranium rod	37·6 in by 1·10 in
Total weight of uranium per reactors	298 tonnes
Core Dimensions:	
Diameter of active core	45 ft 4½ in
Height of active core	24 ft
Diameter of reflector	50 ft
Height of reflector	27 ft 10 in
Lattice (square) pitch	7·75 in
Gas Circuit:	
Mean diameter of reactor vessel	62 ft 6 in
Reactor vessel general thickness	4 in
Gas working pressure	283 lb per sq. in
Number of gas circuits per reactor	4
Diameter of gas ducts	6 ft 6 in
Power input per blower	7 MW
Overall height of boilers	75 ft
Internal diameter of boilers	23 ft 6 in
Shell thickness (graded)	3⅞ in to 2⅞ in
Turbo-Alternators:	
Number of main turbo-alternators	4
Continuous maximum rating/set	142·5 MW
Speed	1,500 r.p.m.
Generator voltage	13·8 kV
Vacuum	28·9 in Hg.
Exhaust wetness	14·3 per cent
Total circulating water quantity	353,000 g.p.m.
Layout:	
Distance between reactor building centres	426 ft
Length of reactor building	316 ft
Length of turbine house, only	385 ft

Capillary Cooling for Nuclear Rocket Engines

A reactor core for rocket propulsion formed from a permeable mixture of fuel and moderator, serves as the reactor vessel and rocket nozzle in a patent awarded to J. J. Grebe by the US Patent Office. (Patent No. 2,894,891) The propellent, hydrogen or helium, is stored in liquid form and is allowed to vaporise on the outer surface of the reactor core. The gaseous coolant then flows through the pores of the fuel-moderator mixture and removes the reactor heat. The patentee claims that the reactor is uniquely adapted for rocket propulsion, making the best use of available high-temperature materials.

Graphite Duty

The Board of Trade have recently stated that they are considering an application for the exemption of duty of natural graphite, in thin flakes, containing not less than 85 per cent carbon and having a density less that 60 grammes per 100 cc.

Reactor Notes

Mitchell's Offer to the Argentine: It is reported that Mr. Myron Widett of Mitchell Engineering has offered the Argentine government to instal nuclear plants and sell electricity to the Government (*British Chamber of Commerce Journal*, May 1960).

Accident at Marcoule: A mechanical break at one of the Marcoule plutonium production piles resulted in the loss of coolant from the reactor.

The

'Engineering' Appointments

Section

COLLEGE OF ADVANCED TECHNOLOGY, BIRMINGHAM

Applications are invited for the following posts:—

DEPARTMENT OF MECHANICAL ENGINEERING

RESEARCH FELLOW in Metal Deformation, Plasticity, Air Lubricated Bearings, or Shaft Vibrations and Whirling

RESEARCH ASSISTANTS in Whirling and Vibrations of Shafts, or Metal Deformation and Plasticity.

DEPARTMENT OF PRODUCTION ENGINEERING

RESEARCH FELLOW in Machine Tools and/or Metrology.

Candidates for Research Fellowships must either have shown exceptional promise in research in science or technology, or in industrial experience relevant to the proposed subject for research. They should possess a good first degree, and a higher degree gained as the result of research work; or possess a college associateship or Diploma in Technology or appropriate professional qualification followed by exceptionally valuable and interesting industrial experience, or appropriate research work in industry, research associations or government establishments. Candidates should submit their own research proposals for consideration. The appointment will be normally tenable for three but not more than four years.

Candidates for Research Assistantships should possess a Diploma in Technology, a university degree or equivalent qualification. The research work carried out may normally be submitted for a higher degree or other appropriate alternative higher qualification. The appointment will normally be tenable for two years but may be renewed for not more than one further year.

SALARY SCALES: RESEARCH FELLOWS: {**(MEN) £700-£1150.** / **(WOMEN) £630-£920** (Plus equal pay increment)

with graduate and training allowances where applicable.

Further details can be given on the basis of the applicant's biographical data. As an indication, it may be noted that an applicant (man) with a good honours degree, or a Ph.D. gained as the result of five years' approved full-time study, would have a starting salary of about £955.

RESEARCH ASSISTANTS, £600-£650

Further particulars and forms of application from the

BURSAR,
COLLEGE OF ADVANCED TECHNOLOGY,
GOSTA GREEN, BIRMINGHAM, 4.

Applications to be received within 14 days of this advertisement. Please quote "K."

K. R. PILLING, *Clerk to the Governors.*

C 581

PUBLIC APPOINTMENTS

SENIOR SCIENTIFIC OFFICERS

The SCIENTIFIC CIVIL SERVICE needs men and women for pensionable posts as (*a*) SENIOR SCIENTIFIC OFFICERS and (*b*) SCIENTIFIC OFFICERS in all major scientific fields, including

PHYSICS
ENGINEERING
CHEMISTRY
METEOROLOGY
MATHEMATICS and
BIOLOGY.

Some particular vacancies include PHYSICISTS/ELECTRICAL ENGINEERS for research in the application of servo-control for machine tools, PHYSICAL CHEMISTS, CHEMISTS for research in high polymers, BOTANIST for study of bryophyta, PHYSIOLOGIST for work at the Institute of Aviation Medicine, MINERALOGIST to work on Meteorites (Petrologist with sound knowledge of Physics preferred), and ZOOLOGISTS to specialise in the taxonomy of the Porifera and in Serological and other histo-chemical techniques applicable in Zoology and Anthropology.

Qualifications: normally first or second class honours degree in science, mathematics or engineering, or equivalent attainment; additionally, for (*a*), at least 3 years' relevant (*e.g.*, post-graduate) experience. Normal age limits: (*a*) between 26 and 32, (*b*) between 21 and 29, with extension for regular Forces service and Overseas Civil Service. Selection by interview. London salaries (men): (*a*) £1233-£1460, (*b*) £655-£1150; provision for starting pay above minimum. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting (*a*) S/53/60, (*b*) S/52/60. C 593

THE SCIENTIFIC CIVIL SERVICE

ASSISTANTS (SCIENTIFIC)

The SCIENTIFIC CIVIL SERVICE needs men and women for pensionable posts as ASSISTANTS (SCIENTIFIC). Ages at least 17½ and normally under 26 on January 1, 1960, with appropriate educational or technical qualifications (normally G.C.E. with passes at "O" or "A" level in 4 distinct subjects including English Language and a scientific or mathematical subject, or O.N.C., or equivalent qualifications) and at least 2 years' experience in either: (i) engineering or physical sciences, or (ii) chemistry, bio-chemistry or metallurgy, or (iii) biological sciences, or (iv) geology, meteorology, or skilled work in laboratory crafts such as glass-blowing. Starting salary (men, London) from £347 10s. (at 17½) to £550 (at 25 or over). Maximum (London), £715. Promotion prospects. 5-day week generally.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S/59/60. C 591

CIVIL, STRUCTURAL, AND PUBLIC HEALTH ENGINEERS

CIVIL, STRUCTURAL AND PUBLIC HEALTH ENGINEERS. Pensionable posts for men and women at least 25 and under 35 on January 1, 1960 (extension for regular Forces service, Overseas Civil Service, established civil service and temporary Government service as Civil, Structural, or Public Health Engineer). Candidates must have achieved Corporate membership of an appropriate professional Institution or have passed examinations necessary for attaining such membership. Some posts require qualifications in certain subjects. Salary (men, London), £830-£1125, according to age, rising to £1300. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form quoting S/64/60. C 592

UNIVERSITY OF TASMANIA

LECTURESHIP OR SENIOR LECTURESHIP IN FLUID DYNAMICS

The University invites applications for the above-mentioned position.

The salary grades for Lecturers are Grade II £A1450-60-£A1630, and Grade I £A1630-60-£A2050, and for Senior Lecturers, £A2150-60-£A2510. It is expected that by the time the appointment is made these scales will be Lecturer Grade II £A1610-70-£A1860, Lecturer Grade I £A1860-70-£A2350 and Senior Lecturers £A2450-70-£A2870. Appointment will be offered within one of the grades according to qualifications and experience.

Further particulars and information as to the method of application may be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH 36 GORDON SQUARE, LONDON, W.C.1.

Applications close, in Australia and London, on 7th SEPTEMBER, 1960. C 585

TECHNICIANS

MINISTRY OF AVIATION, WOOLWICH LONDON, require TECHNICIANS to assist in the preparation of specifications, inspection instruction and technical details for contract action, and the vetting of drawings for steel ammunition packages. Qualifications, recognised engineering apprenticeship, O.N.C., appropriate C. & G. Final Certificate or equivalent. Experience in the production or inspection of sheet metal work and pressings. Salary, £720 (age 26)-£900. Application forms from MANAGER (P.E. 2203), MINISTRY OF LABOUR, PROFESSIONAL AND EXECUTIVE REGISTER, ATLANTIC HOUSE, FARRINGDON STREET, LONDON E.C.4. C 594

BRITISH TRANSPORT DOCKS

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SOUTH WALES

(1) SENIOR ENGINEERING ASSISTANTS, BARRY £1150-£1330 p.a. (Corporate Membership Institution of Civil Engineers)	Experience in design, specification, construction and execution of general civil engineering works, preferably with knowledge of dock and harbour installations.
(2) ENGINEERING ASSISTANTS, BARRY AND CARDIFF. Up to £1034 p.a. according to experience (Graduates of Institution of Civil Engineers)	Assist in preparation of drawings, estimates and contract documents for docks civil engineering works.
(3) ENGINEERING ASSISTANTS, BARRY, CARDIFF AND NEWPORT. Up to £948 p.a. according to experience (Higher National Certificate)	Experience in preparation of schemes and estimates for general civil engineering construction. Some experience on works.
(4) ENGINEERING ASSISTANT, BARRY. Up to £948 p.a. according to experience (Higher or at least Ordinary National Certificate)	Knowledge of permanent way work with experience in surveying and design of layouts, calculation for point and crossing work, requisitioning of materials.

Contributory superannuation scheme and certain rail travel facilities.

Applications, giving age, education, training, experience and qualifications, not later than 3rd August, to:—

CHIEF DOCKS MANAGER,
BRITISH TRANSPORT DOCKS, PIERHEAD BUILDING, CARDIFF, GLAM. C 607

BCL

BRITISH CELLOPHANE LIMITED

require a

TECHNICAL SERVICE MANAGER

Applications for the position of Technical Service Manager are invited from men, aged 30/40, having the following qualifications:—

A good Science or Engineering degree.
Successful Management experience.
A balanced interest in current market problems and long-term use development.
Enthusiasm, drive and ability to get on well with people.
A practical knowledge of packaging—particularly in respect of Plastic and/or Cellulose films would be an advantage.

The Technical Service Manager will be based on London, W.1, and will be responsible for departmental control of Technical Service Representatives, a Laboratory and a Machine Development Section. He will be required to establish and maintain first class relationship with the Company's customers both in the United Kingdom and overseas by personal contact where necessary. Interviews will take place in London.

Applications to Personnel Officer, British Cellophane Ltd., Bridgwater, Somerset

C554

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The work is connected with their world-wide activities in the chemical industry.

Honours degree or A.M.I.Mech.E. essential.

Candidates with chemical plant design and/or construction experience would be preferable.

The upper age limit is 34 years, but possibly higher for candidates who have had exceptional experience in this particular field.

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Personnel/Recruitment/HME, No. 17,
St. Swithin's House,
London, E.C.4.

C 470

PAISLEY TECHNICAL COLLEGE
MECHANICAL ENGINEERING DEPARTMENT

Applications are invited for the following posts:—
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(*b*) LECTURER IN PRODUCTION ENGINEERING.

Salary, according to experience and qualifications, on one of three scales up to a maximum of £1700. The appointees will be required to teach, for post (*a*) at honours degree level, for post (*b*) Production Engineering subjects at Higher National Diploma level.

Applications, stating age, qualifications and experience, together with names of three referees, should be addressed to the undersigned from whom further information may be obtained.

H. N. HENRY,
PRINCIPAL.
PAISLEY TECHNICAL COLLEGE,
28-40 GEORGE STREET,
PAISLEY. C 597

EAST SUFFOLK COUNTY COUNCIL
BOROUGH OF LOWESTOFT COMMITTEE FOR EDUCATION
LOWESTOFT COLLEGE OF FURTHER EDUCATION

PRINCIPAL: J. G. MILLER, B.A., B.Sc., A.M.I.Mech.E.

Applications are invited for the following post for 1st January, 1961.

ASSISTANT GRADE "B" to teach ENGINEERING DRAWING AND CALCULATIONS in National Certificate and City and Guilds courses.

Salary in accordance with the Burnham Technical Report, 1956.

Grade "B," £700 per annum by £27 to £1150.

Application forms and detailed particulars, on receipt of a stamped addressed envelope, from the BOROUGH EDUCATION OFFICER, 49 HIGH STREET, LOWESTOFT, to whom applications should be submitted within 14 days of the date of this advertisement. C 598

BOROUGH OF TOTTENHAM

RESIDENT ENGINEER. Salary £1265 p.a. to £1420 p.a. inclusive for supervision of construction of large diameter concrete sewers, reinforced-concrete culverts and manholes and sewer in tunnel.

Application form and particulars from BOROUGH ENGINEER, TOWN HALL, N.15 (EJ). Applications to be delivered by THURSDAY, 28th JULY, 1960. C 567

DESIGNER DRAUGHTSMEN

AIR MINISTRY, Works Designs Branch, requires in LONDON, STRUCTURAL ENGINEERING DESIGNER DRAUGHTSMEN for reinforced concrete or structural steelwork of all types. Applicants must have adequate training and several years' experience. Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially. Salary ranges from £680 (at age 25) to £900 p.a. Commencing salary dependent on age, quals. and exp. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.d., LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or apply to any Employment Exchange quoting Kings Cross 3745, giving age, details of training, quals., full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 888

PROJECTS ENGINEER
(REACTORS)

required by the

UNITED KINGDOM ATOMIC ENERGY AUTHORITY
PRODUCTION GROUP

to assist the Chief Projects Engineer at the Group Headquarters, Risley, Nr. Warrington, Lancashire, in the execution of major capital projects which involve major improvements and extensions to existing reactors and their ancillary equipment. The successful candidate will be required to assist in the preparation of the case for financial approval and the specification of work required, and advise on the main engineering features of design.

Qualifications and experience—Applicants must have served a recognised engineering apprenticeship and be corporate members of the Institution of Mechanical Engineers or hold equivalent qualifications. A sound knowledge of mechanical engineering design and construction is required.

Salary.—Within the range £1880-£2180 according to qualifications and experience. Contributory superannuation. Staff housing scheme.

Send postcard for application form, quoting reference P.160/J2, to Staff Officer, United Kingdom Atomic Energy Authority, Risley, Nr. Warrington, Lancashire.

Closing Date: 1st August, 1960

C 570

EXPERIMENTAL/ASSISTANT EXPERIMENTAL OFFICERS

AIR MINISTRY require EXPERIMENTAL/ASSISTANT EXPERIMENTAL OFFICERS in Soils Laboratory, Cardington, Bedford. DUTIES to take charge of small soil survey teams engaged on foundation investigations for runways, buildings and other civil engineering works at airfields and R.A.F. stations and to progress and supervise associated laboratory testing. Work requires ability to use Geological Survey maps and publications in the interpretation of results of the survey. QUALIFICATIONS: H.N.C., H.S.C. or School Certificate with passes in two Mathematical or scientific subjects at "A" level (preferably including geology) or equivalent qualification. Wide experience in responsible capacity in connection with field surveys and associated standard laboratory tests for soils investigations is essential for appointment as E.O. Salary: E.O. £954-£1166; A.E.O., £382 10s. 0d.-£830.—Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting reference E.518/9A. C 590

MILLING MACHINE OPERATOR

MILLING MACHINE OPERATOR required by MINISTRY OF LABOUR for appointment as INSTRUCTOR (Unestablished but with possibility of eventual establishment) at the GOVERNMENT TRAINING CENTRE, LEICESTER. Applicants must be British subjects who are experienced and fully skilled, able to teach their trade, able to supervise the work and maintain control of trainees engaged in their trade. They should have undergone the normal trade training followed by at least 5 years' skilled experience. Applicants should preferably possess O.N. or C. & G. certificate or equivalent qualifications where appropriate. Selected applicants will be required to pass a theoretical test before interview and the successful candidate a practical test of normal trade skills. Commencing salary (at age 30 or over), £955 rising by annual increments to £1030 p.a.—Write for application form to the MANAGER, GOVERNMENT TRADING CENTRE, HUMBERSTONE LANE, LEICESTER, within seven days. C 595

SOUTH EAST METROPOLITAN REGIONAL HOSPITAL BOARD

Applications invited for the following posts:
(*a*) **ENGINEERING DRAUGHTSMAN** (Electrical)
(*b*) **ENGINEERING DRAUGHTSMAN** (Heating and Ventilating)

Salary within the range of £570-£1300 according to experience and qualifications. Preference will be given to candidates who hold the Higher National Certificate or Sections A and B of the Institution of Heating and Ventilating Engineers (or equivalent) and have had suitable practical and theoretical training including site or workshop experience. Consideration will be given to experience as alternative to qualifications.

Applications, stating age, qualifications, experience and present salary, with names of three referees, should reach the SECRETARY, 40, EASTBOURNE TERRACE, W.2, by 2nd AUGUST. C 599

ROYAL TECHNICAL COLLEGE SALFORD

Applications are invited for a SENIOR LECTURE

Applications are invited for a SENIOR LECTURER IN ENGINEERING MANAGEMENT at a salary of £1550, rising to £1750, p.a.

Applicants should have an honours degree or its equivalent together with industrial experience. Teaching and research experience are important additional qualifications. The person appointed will teach industrial administration and management subjects and will be expected to assist in the organisation and teaching of post-graduate courses. Staff will be encouraged to participate in professional consulting work and in research for which there are excellent facilities.

Further particulars and forms of application may be obtained from the REGISTRAR, ROYAL TECHNICAL COLLEGE, SALFORD, 5, LANCS., to whom completed forms must be returned by 12th AUGUST, 1960. C 604

GOVERNMENT OF TANGANYIKA

CONTROLLER OF APPRENTICES AND TRADE TESTING (MALE, AGED 30 to 40) REQUIRED.

(i) To assist in the encouragement of apprenticeship schemes, the drawing-up and registration of suitable apprenticeship agreements, the placing of apprentices with suitable firms and supervision of their training.

(ii) To initiate schemes of trade testing of artisans of all nationalities in a variety of trades connected with the major industries in the Territory.

(iii) To advise on the framing of any legislation relating to apprenticeship or trade testing schemes or to industrial training in general.

(iv) In carrying out these duties the Controller will be required to collaborate, when necessary, with the other appropriate authorities in Tanganyika and in the other East African Territories.

Candidates must possess wide practical knowledge of manual skills, craft processes, apprenticeship schemes and testing techniques under advanced industrial conditions. Industrial experience should be supported by sound theoretical knowledge relating to building or engineering industry and candidates must be able to mix well with their colleagues in Technical Education and representatives of employers and workers. Candidates with degree in Engineering or Science or equivalent, i.e., A.M.I.C.E., A.M.I.E.E., or A.M.I.Mech.E., preferable. Post on contract/resettlement grant terms. Salary scale, £1677-£1863 inclusive. Quarters at low rental. Free passages and medical attendance. Education allowance (in respect of children educated in secondary schools outside Tanganyika). Tour of service 30-36 months. Low income tax. Generous home leave. Further particulars and application forms from the DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, quoting BCD.132/8/06/D5. CANDIDATES SHOULD STATE THEIR FULL NAMES ON APPLYING. C 606

ROYAL TECHNICAL COLLEGE, SALFORD

DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for appointments in this College of Advanced Technology of SENIOR LECTURERS in—

(*a*) MECHANICS OF MACHINES
(*b*) STRENGTH OF MATERIALS
(*c*) PRODUCTION ENGINEERING

Applicants should have an honours degree, or equivalent, in engineering or applied science, and industrial, research or teaching experience. Applicants for post (*a*) should preferably have had experience in mechanical vibrations or control systems; for post (*c*) research or industrial design experience in machine tools or related topics would be of advantage.

The persons appointed will be expected to take a leading part in the teaching of their subjects in the Department and to carry out research, for which excellent facilities exist. Subject to reasonable safeguards, staff are encouraged to engage in consulting work for industry.

These posts offer excellent opportunities to take part in the development of Technological Education in the present important phase of its growth.

The salary scale is £1550 p.a., rising to £1750 p.a. Appointments may be made at appropriate points. Exceptional candidates may be considered for appointment as a PRINCIPAL LECTURER in the salary range £1750 p.a., rising to £1900 p.a.

Further particulars and forms of application may be obtained from the REGISTRAR, ROYAL TECHNICAL COLLEGE, SALFORD, 5, LANCS., to whom completed forms must be returned by 12th AUGUST, 1960. C 605

APPOINTMENTS OPEN

THE BURMAH OIL CO. (PIPE LINES) LTD., BRITANNIC HOUSE, FINSBURY CIRCUS, E.C.2.

have the following interesting vacancies for Engineers for service in India on a major crude oil pipeline project. Appointments will be on a bachelor basis.

Salaries free of Indian Taxation will be paid in Rupees (equivalent Sterling rates per annum are quoted below) and will be related to qualifications and experience. Messing and accommodation in India will be provided free.

SUPERINTENDING ENGINEERS (THREE)

Required to supervise inspection of Contractors' operations on Main Pipelaying Spreads and measurement of completed work and to take administrative charge of inspectors on the spread.

Minimum age 30/35. Preference will be given to men with mechanical and civil engineering qualifications. Previous experience on welded pipelines essential.

Required September, 1960. Salary range, £2160 to £2700 p.a.

PIPELINE INSPECTORS (SIX)

Required to provide general supervision over locally engaged inspectors on right-of-way clearance ditching, pipe stringing, bending, tie-ins, lower and back fill.

Preference will be given to men with previous practical pipeline experience.

Minimum age 30 years and required by 1st October 1960.

Salary range, £1620 to £2160 p.a.

RESIDENT ENGINEERS—RIVER CROSSINGS (TWO)

Required to supervise inspection of Contractors' work on submerged and overhead pipeline crossings of rivers and to supervise locally engaged inspection staff. Should be qualified Civil or Structural Engineers with experience of either erection of steel structures, piling foundations, cable suspension bridges, etc., or earthworks, draglines, dredging and well-point dewatering.

Age 30 to 40 years. One required immediately and one 1st October.

Salary range, £1800 to £2250 p.a.

CIVIL CONSTRUCTION ENGINEERS (TWO)

Required to supervise setting out and construction/erection of Domestic and Industrial buildings and services. Previous experience of contract work of a similar nature essential.

Minimum age 30 years—one required immediately and one 1st October.

Salary range, £1620 to £1980 p.a.

TECHNICAL ASSISTANT (ONE)

Required immediately to assist Chief Engineer on design and technical coordination. Should be a qualified Mechanical Engineer with previous pipeline experience.

Minimum age 25. Salary range, £1620 to £2070 p.

C 601

Nuclear Fuel Element Development

The Research and Development Branch of the Development and Engineering Group carries out work on the fuel elements for the Calder Hall and Chapelcross reactors, for the reactors under construction for the C.E.G.B. and S.S.E.B., for the Advanced Gas-Cooled Reactor under construction at Windscale and for some more advanced reactor systems. The main centre of the Authority's development work on fuel elements is the Springfields Laboratories, near Preston.

Springfields Laboratories are responsible for carrying out development work on the manufacture and properties of the fuels and cans and for the assembly and testing of the fuel elements to prove their endurance under the design operating conditions within the project time-table. This includes making test specimens for irradition in U.K. and overseas materials testing reactors. There are teams of Metallurgists, Physicists, Mathematicians, Mechanical Engineers, Chemists and Chemical Engineers working on the metallic uranium/magnesium alloy, uranium dioxide/stainless steel and uranium dioxide/beryllium clad fuel elements. ***Applications are invited for the undermentioned specific vacancies at salaries within the scales quoted. Other vacancies will be arising in the near future on salary scales within the range £420-£2,180 and applications would be welcomed also from scientists and technologists with academic or professional qualifications, and experience in the disciplines mentioned above.***

RESEARCH MANAGERS

At each stage in the development programme when decisions have to be made on design, the ability of the fuel elements to meet the operational requirements is evaluated. The techniques of theoretical and experimental fuel element evaluation have largely been developed at Springfields and the team is to be expanded at the level of Research Manager.

RESEARCH MANAGER—Fuel Element Assessment (Theory) (£2,400-£2,900)

to undertake and to direct theoretical studies aimed at the prediction of fuel element performance. The work covers the critical appraisal of experimental data, formulation of theories on material behaviour, study of the stresses and of specific problems of fuel element detail and the integrated problem of life prediction. Theoretical work on the plasticity of materials is used to a considerable extent. This post is suitable for applied mathematicians, physicists and engineers. (Ref. 299A/J2.)

RESEARCH MANAGER—Fuel Element Assessment (Mechanical) (£2,400-£2,900)

to undertake experimental studies on the ability of fuel elements to perform satisfactorily as mechanical structures subject to changes in dimensions and operational conditions. The work involves basic problems of fatigue and creep of fuel element components and the design and mounting of experimental work simulating actual and accelerated reactor conditions. A mechanical engineer with experience of large scale research and development work is required for this post. (Ref. 299B/J2.)

EXPERIMENTAL AND ENGINEERING POSTS

DESIGN ENGINEER—(£1,880-£2,180)

to be responsible for the design and specification of experimental equipment used in the Laboratories. The post requires close collaboration with project engineers and scientific staff and will involve technical negotiation with contractors' design offices. Experience of the design of experimental equipment would be an advantage. (Ref. 299C/J2.)

CHEMICAL ENGINEER—(£1,535-£2,180)

to lead a team responsible for conceptual designs and feasibility studies for new projects, to initiate and to operate pilot plants in order to prepare plant specification and flow sheet reports for the full scale design. Recent experience in the field of chemical processing together with an interest in applied kinetics of chemical reactions are necessary. (Ref. 299D/J2.)

PROJECT ENGINEER—(£,1370-£1,825)

to work with a Chemical Engineering Group engaged on the development of uranium processing methods. The project engineer is required to formulate the engineering requirements of the Group in collaboration with scientific staff and to design or to supervise the design and manufacture of the experimental plant by external contractors. (Ref. 299E/J2).

CHEMIST OR CHEMICAL ENGINEER—(£1,285-£1,500)

to be responsible for the small scale laboratory work arising from the work referred to in post reference 299D/J2. A knowledge of the techniques used in applied reaction kinetics, with particular reference to gas-solid reaction, is necessary for this post. (Ref. 299F/J2.)

MECHANICAL ENGINEER—(£860-£1,340)

to assist in the design, construction and commissioning of experimental rigs. (Ref. 299G/J2.)

CHEMIST OR CHEMICAL ENGINEER—(£860-£1,340)

to control the service, including the supply of toxic gases, to the experimental plants and equipment installed in a large chemical engineering laboratory. The post carries responsibility for the general housekeeping of the laboratory. (Ref. 299H/J2.)

Applicants for these specific vacancies must have experience in research or industry commensurate with the post applied for. Corporate membership of a senior professional institution or at least a second class honours degree is required.

Staff Housing Scheme. Superannuation Scheme.

Send postcard for application form, quoting appropriate reference number, to

Group Recruitment Officer,

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

(Development & Engineering Group Headquarters)

Risley, Warrington, Lancashire.

Closing Date: 8th August, 1960. C 579

MITCHELL ENGINEERING LIMITED

invite applications from

EXPERIENCED SENIOR DRAUGHTSMEN

for the following positions

PETERBOROUGH OFFICE.	Section Leaders.
LONDON OFFICE.	Designers and Detailers for Large Contracts.
LONDON OFFICE.	Project men for the preparation of schemes and Estimates.

Applicants must have had wide experience in all types of Mechanical Handling Equipment for bulk materials in Steelworks, Power Stations, Collieries, etc., and must be capable of working with a minimum of supervision.

Good Salaries will be paid in accordance with experience. Three weeks' holiday after one year service. Contributory Pension Scheme available. In the first instance replies must state age, experience and salary required and should be addressed to:—

Room No. 1,
Tavistock House North,
Entrance D,
Tavistock Square,
London, W.C.1.

C 578

STRESS ENGINEER

DAVY AND UNITED ENGINEERING COMPANY LIMITED

the largest producers and designers of rolling mill equipment in Great Britain require a Graduate Mechanical Engineer with experience of stressing techniques to expand and develop an existing stress section.

He will be responsible to the Chief Engineer for the development of standard analytical approach to general design problems, this work will entail the theoretical analysis of dynamic machines and structures subjected to impact and thermal loading. Complete research facilities exist for fundamental investigations into problems encountered, these facilities include a field research team equipped to carry out stress measurement on working components, research workshop together with a photo elastic bench. Knowledge of heavy welded fabrication techniques would be an advantage but is not essential.

Comprehensive amenities, Superannuation Scheme.

Apply with full details of age, experience and qualifications to:—

PERSONNEL DEPARTMENT,
DAVY AND UNITED ENGINEERING COMPANY LIMITED,
DARNALL WORKS, SHEFFIELD 9.

C 589

REFRIGERATION ENGINEER

UNILEVER LIMITED have a vacancy for a Refrigeration Engineer in their London Office. Applicants should have received fundamental training in Refrigeration and should have had substantial practical experience in this field. It is desirable that they should be knowledgeable on at least the first 2 of the following 3 subjects:—

1. Refrigerated Transport Vehicles.
2. Large Industrial Refrigeration Plant.
3. Cold Store Design.

Candidates should preferably be corporate members of the Institute of Mechanical Engineers and should have obtained a Diploma in Refrigeration Engineering. Salary will be compatible with experience.

Applications, in writing, giving details of training and experience, should be addressed to HEAD OFFICE STAFF DEPARTMENT (WF/62), UNILEVER HOUSE, BLACKFRIARS, LONDON, E.C.4. C 586

DRAUGHTSMEN

An opportunity for gaining experience in factory services, plant layout and machinery development exists for DRAUGHTSMEN, around the age of 20-23 years, with Schweppes Engineering Department. Applicants should have served an apprenticeship, or have equivalent workshop experience followed by at least two or three years' drawing experience, preferably on the works engineering side. O.N.C. or study towards it would be an advantage. —Apply in writing with brief details of training and experience, stating present salary, to ASSISTANT PERSONNEL MANAGER (Ref. MRL), SCHWEPPES HOUSE, CONNAUGHT PLACE, W.2. C 573

THE JOSEPH RANK GROUP

BRITISH BAKERIES LIMITED

wish to appoint a young

MECHANICAL ENGINEER

to take charge of new projects as the senior member of a design team, concerned with the development of special-purpose machinery and devices. The successful candidate will be required to set up a small drawing office and organise its work. He will be responsible to the Consultant Engineer, and be based in London.

Applicants should be 28/35 and either graduate or chartered engineers. Salary according to age, qualifications and experience. This is an interesting and progressive appointment.

Apply with relevant details to:—

THE GROUP STAFF MANAGER,
BRITISH BAKERIES LIMITED,
53, EASTCHEAP,
LONDON, E.C.3.

C 609

ENGINEER

HIGHLY QUALIFIED ENGINEER required by major cycle manufacturers in INDIA. Must have had practical experience in latest production techniques and operation of automats. Excellent salary and home leave arrangements: free furnished house and other facilities. This is an unusual opportunity for an executive engineer capable of adapting himself to local conditions, who possesses drive and initiative as well as experience and who is seeking a permanent career in Asia.—BOX C 582, Offices of ENGINEERING.

DESIGN AND CHEMICAL PLANT LAYOUT DRAUGHTSMEN

Design and Chemical Plant Layout Draughtsmen required. Structural Steelwork or Instrument Installation experience an advantage. Excellent conditions in new Drawing Office. Superannuation and Life Insurance Scheme. Canteen facilities.—Apply in writing, giving full details of past experience, and salary required, to:
NORDAC LIMITED, UXBRIDGE, MIDDLESEX. A Member of the Woodall-Duckham Group of Companies. C 576

SITE ENGINEER

SITE ENGINEER required by well-known firm manufacturing a wide range of Mining, Roadmaking and Quarry Plant. Must be capable of directing all aspects of plant erection and controlling labour.—Full details of experience, age, salary required and when available, to BOX C 536, Offices of ENGINEERING.

TECHNICAL SALES ENGINEER

TECHNICAL SALES ENGINEER, age 25/30, required by Chemical Engineering firm for position in London offering excellent prospects. Qualifications required are training to B.Sc., or equivalent and good knowledge of physics and heat transfer. Grounding in chemistry advantageous. Send full particulars, including salary required, to BOX C 608, Offices of ENGINEERING.

DESIGN DRAUGHTSMAN

DESIGN DRAUGHTSMAN required to work in Westminster area to assist in designing prototype marine propulsion gears. Position permanent and pensionable.—Apply in first instance in writing to TECHNICAL MANAGER, MODERN WHEEL DRIVE, LTD., LINDO LODGE, CHESHAM, BUCKS. C 538

ASSISTANT CHIEF ENGINEER

CIVIL AND MECHANICAL ENGINEER required to fill the above vacancy in a large oil storage installation at Thames Haven, Essex.

Applicants between the ages of 40-45 should have a degree in engineering, together with long-term practical experience including administration, planned maintenance and budgetary control.

Salary commensurate with age and experience. Contributory Pension Scheme.

Write, giving details to:—

THE MANAGING DIRECTOR,
LONDON AND THAMES HAVEN OIL WHARVES LTD.,
BUCKLERSBURY HOUSE,
83 CANNON STREET,
LONDON, E.C.4.

C 588

MECHANICAL ENGINEER

A small but substantial firm of electro-mechanical engineers in the Hounslow area wishes to appoint a fully qualified Chartered Mechanical Engineer with 5 to 10 years' experience in the design and development of precision mechanisms. An applicant of sufficient calibre will be considered for the post of CHIEF MECHANICAL ENGINEER.

A salary of up to £2000 per annum is envisaged and the usual staff amenities apply. Working conditions are good.

Applications, which will be held in absolute confidence, should be addressed for the personal attention of the TECHNICAL DIRECTOR, BOX EG.475, c/o HANWAY HOUSE, CLARK'S PLACE, E.C.2. C 600

APPOINTMENTS WANTED

COMPANY SECRETARY/EXECUTIVE

Chartered Accountant (30), four years as company secretary/administrative executive of large London company, seeks change to similar position with progressive company in Suffolk, Essex, Kent or Sussex.—BOX C 580, Offices of ENGINEERING.

ADVERTISEMENT RATES

'Engineering' Appointments Section

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates:	per page (12 in. by 9 in.)	£100
	half page	£54
	quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates:	per page (12 in. by 9 in.)	£100
	per half page	£54
	quarter page	£29
	per single column inch	£2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line	4s. 6d.
(Minimum charge 18s.)	

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26; 20 per cent, on 52.

BOX NUMBER: 2s.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Companies

Fortunes of a Cable Group

MORE than any other companies the cable firms will be involved if the unrest in the Congo has a permanent effect on the price of copper.

In the year up to the end of this March copper prices moved between £209 at the bottom and £277 at the top, a position, combined with careful buying, which considerably assisted the PYROTENAX cable company in its trading for the year.

Its profits before tax rose from £740,276 in the previous year to £808,133. In his annual report prepared before the Congo flare up, Sir Brograve Beauchamp, the Pyrotenax chairman, said that the confidence he had expressed was so far justified in the results this year. Given stable economic conditions he expected the group to give a good account of itself.

In anticipation of increased sales cable and accessory prices were cut early in 1959. Greater turnover followed, leading on, with the improvement in operational efficiency, to the better overall profit returned.

Among the overseas subsidiaries, PYROTENAX OF CANADA improved its total sales and there was an improvement in sales under licence in the United States. The import and home credit restrictions of the New Zealand authorities have made life difficult for the associated company, GILES AND ELLIOTT for the past two years. Some easing of the restrictions occurred last year but cable trading conditions have not yet returned to normal for Pyrotenax imports. Livelier trading in some allied products maintained the local company's profitability.

Three subsidiaries conduct the company's activities in Australia. One of them, PYROTENAX CABLES Pty., is to be equipped over the next two years for the production of finished cables from locally purchased materials, wherever this is economic. The financing of this extension of the subsidiary will be initially from Pyrotenax in Britain.

Vigour, Variety and Decentralisation

While many companies like to take one important step forward at a time the MORGAN CRUCIBLE Company has in the past year been engaged on a multitude of simultaneous steps. At the same time the group finished the year with profits before tax increased from £1,766,000 to £2,091,000.

Sales were 17½ per cent up on the previous year and the proportion of overseas sales was 45 per cent of the total turnover.

The many forward moves being made by Morgan, set out in the current annual report, are as varied at home as in the foreign subsidiaries. The company's crucible department returned better sales and profitability, much of the improvement coming from the up-to-date Suprex factory at Worcester. A large reorganisation of the crucible factory at Battersea, London, SW, did not deter the general increase in the department's figures.

Negotiations are now well advanced with BRITISH BELTING AND ASBESTOS Limited to form a joint company for the exploitation of the Morgan interests in the market for sintered metal friction materials in the machine tool, motor and earth moving equipment industries.

The research and development department is growing at a pace which leads to the formation of a separate fundamental research research unit at Wandsworth.

The re-siting of part of the factory of MORGAN REFRACTORIES Limited was completed in time for that company to benefit from the improved demand in the last months of the year.

Overseas the Canadian and South African companies have moved into larger factories and the Australian works, expanding during the year, is preparing against long term improvement. In Mexico a small company is fulfilling the hopes of increased Morgan sales in Central America.

Belgium, France and Italy are all the scene of growing or maturing activities. Steps will be announced at the annual meeting that are preliminary to the "logical conclusion" of Morgan's 12 year old policy of decentralisation.

A Good Year for Simms and Sound Prospects

Describing current orders and output as at record levels, Mr. G. E. Liardet, chairman of the SIMMS MOTOR AND ELECTRONIC Corporation, went on to assure the company's annual meeting that he hoped the annual report next year would be at least as good as the one now published.

Shareholders did not have long to wait for evidence that the Simms concern has the impetus in its affairs to bring this about. The purchase of DAWE INSTRUMENTS Limited, an electronics firm that has advanced a long way in the scientific industry since its formation as a company in 1945, was announced by the chairman in the course of his report.

Among the electronics equipment manufactured by Dawe is that for aircraft, shipping, vehicle production, power, radio and television and iron and steel. Some of the company's most recent work is on a range of fully transistorised instruments.

With the acquisition of Dawe, and their associated manufacturing company, L.M.K. MANUFACTURING, of Brentford, Middlesex, the Simms corporation, which recently benefited from the absorption of CAWKELL RESEARCH AND ELECTRONICS, presents on its electronics side a well spread range of component manufacture, instrumentation and applications.

The Simms group as a whole, with its widespread automobile interests, made a profit before tax last year of £1,037,690, more than 60 per cent above the 1958 profit of £632,072. While better performance from the majority of the group's companies was adding up to the improved result the important electronic research laboratory was being moved from London Colney, Hertfordshire, to a larger building at Park Royal, London, NW.

At the hydraulic research laboratory useful progress is being achieved into diesel fuel injection equipment, oil burners and certain other hydraulic products.

On the effects of the shorter working week in the engineering industries, Mr. Liardet said that it has now seriously increased labour costs. High capital investment in plant and the current high level of activity had only partly offset this increased cost.

The extra labour cost, coupled with its further reflection in the prices of supplies and other elements made an increase in selling prices inevitable. As the chairman said, only increased productivity can meet this increased danger of inflation.

Whether the present economic conditions as they have now been set will allow this to be achieved cannot yet be known with certainty.

Albert Reed Faces EFTA Tariff Cuts

Since everything from cornflakes to heavy civil engineering parts have to be packed at some stage in their life the success or otherwise of a major paper products firm is a useful index of the nation's trade and manufacturing.

ALBERT E. REED with 74 per cent of its group sales last year in converted

packaging products and wrapping paper has had a very good year indeed.

The turnover for the year up to the end of this March was £73,995,813, over £7 million more than the £66,234,389 of the year before. Trading profit for the year increased from £6,000,922 to £6,957,520.

It has yet to be seen what effect the tariff reductions of the European Free Trade Area, which includes the Scandinavians with their integrated wood pulp interests, will have on the United Kingdom's paper makers. Lord Cornwallis, the Albert Reed chairman (inset) declares in his annual report that the company is well enough based to meet and overcome any such difficulties.

Relevant to this position is the decision to create jointly with SANDE TRESLIPERI, of Norway, a pulp and paper mill to produce corrugating medium. This is a paper used in corrugated cases, a sector of Albert Reed's output in which they are one of the largest producers in Europe.

The mill is now being built and it is expected that it will be in production early in the summer of 1961.

In New Zealand the TASMAN PULP AND PAPER Company made a profit of £151,568 after providing for depreciation charges of more than ten times that amount. The BOWATER PAPER CORPORATION was invited and agreed to take an equal interest in the development of this New Zealand company. When the second newsprint machine is installed the Tasman Company's potential capacity will be about 180,000 tons of newsprint, 30,000 tons of market pulp and 60 million board feet of timber.

The controllers of the Scandinavian paper industry were not proud of the violent fluctuations of prices in previous years due to the uncontrolled exploitation of a supply and demand situation, said Lord Corwallis.

He believed that those responsible were now more interested in long term stabilisation and development, recognising that the temporary exploitation of any situation to the disadvantage of their competitors was a policy that could get out of hand and benefit no one.

Forecasting some increases in prices, Lord Cornwallis reported that raw material prices were now rising and pointed out that increased efficiency of operation could not indefinitely keep pace with permanently rising costs.

France Steps Up the Gas

Not so long ago the French were having special provisions written into the Coal and Steel Community in order to safeguard their energy supplies. Now the one thing there is more of than anything else in France is energy. Next year the natural gas output of the Lacq field is expected to reach its maximum output. The target figure is 20 million cubic metres a day.

By any reckoning that is a lot of gas. Last year natural gas accounted for a third of French gas consumption. Next year the proportion will be considerably higher. What happens to it all? The short answer is that like the products of the North Thames Gas Board or any other producer it is carried in pipes to industrial and domestic users in the main consuming centres. The difference is that in this case the gas is moved by a 900 Km pipeline that has now been in operation for over a year.

Lacq is down in the South-west corner of France near the Pyrennees. The main pipelines run North to Augoulême and Paris, with branches off to Nantes in the North west, and Lyons and Dijon in the East. Smaller branches cut off from these main lines to such places as Saint Etienne, Bayonne and Cognac. Last year the total consumption of gas from all sources in France was 46 per cent up on 1951, but only 2 per cent above 1958.

Falling Coal Use

Industrial consumption was 31 per cent above the 1958 level—largely at the expense of fuel oil and coal. Household and commercial consumption of gas stayed at the 1958 level. The supplying companies working the Lacq find St. Marcet fields are Societé Nationale des Gaz du Sud-Ouest, which is jointly owned by SNPA, RAP and Gaz de France; Compagnie Francaise du Méthane jointly owned by SNPA and Gaz de France; and by RAP itself. The increased use of natural gas has greatly reduced the demand for coal by the gas works. The amount of coal carbonised in Gaz de France's works reached a peak of just under 5 million tons in 1952. Last year the figure was 27 per cent lower at 3,627,000 tons. All this should add up to very satisfactory energy position in France.

There are some big snags however. One is the unsold stocks of coal at the French pitheads. Another is the problem of what to do with the vast quantities of natural gas which have been discovered in the Sahara. And the same difficulty arises over Saharan oil.

Automatic Control for a Turret Press

An automatic control system fitted to a turret press has resulted in a higher output and a considerable reduction of operator fatigue.

AN AUTOMATIC control system for a Wiedemann turret press has been devised and put into operation by the control engineering group of the GEC research laboratories working in cooperation with engineers from the company's Witton Works.

Presses of this type are used to punch out the sheet steel panels used in the manufacture of indoor switchgear panels. The panels are punched with a series of standardised apertures corresponding to the instruments, relays and accessories fitted to the switchgear cubicles. Until recently, the presses had been operated manually, and the decision to develop an automatic system of control was influenced by the fact that the operators tired rapidly from the strain of continually watching the scales which indicated the position of the panel relative to the punch.

The new system makes use of teleprinter punched tapes to initiate electrical impulses which are translated into machine movements by means of telephone relays.

MANUAL CONTROL

The presses have a capacity of 71 tons and are fitted with turrets containing 32 sets of punches and dies together with an air operated centre punch giving a total of 33 stations in all. Any of these stations can be positioned under the press ram by rotating the turret. The top half of the turret carries the punches and the lower half the dies: each half being driven separately by chains from a common shaft. The machine table is provided with two movements, one in a direction parallel to the machine axis (the Y axis) and the other at 90° to the first (the X axis).

The slides are positioned by two handwheels to which are attached measuring scales marked in increments of $\frac{1}{4}$ in which cover the full movements of the slides—verniers enable the required dimensions to be set to $\frac{1}{64}$ in. The operator stands on a platform which is attached to the Y direction slide and hence moves in and out with the component. The handwheels and the push buttons for actuating the ram and the turret are positioned so that they can be operated from this platform.

The operator is supplied with a chart showing the station number and the coordinates for each punch stroke. This chart is compiled by the programmer who converts the component drawing into this form.

DIGITAL CONTROL

For the automatic scheme, punched paper tape was chosen for programming the instructions to the press, and it was decided to employ digital control throughout, using the well-tried PO type 3,000 relay, together with a number of rotary switches. Two small d.c. motors were fitted to drive each table movement, giving three-speed control, and the induction motor driving the turret was replaced by a two-speed d.c. motor.

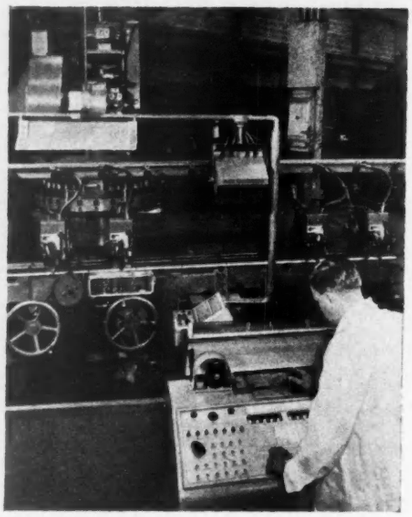
When the press is under automatic control, the tape, carrying the information for punching a complete plate, is run through the tape reader. The perforations are read in discrete phrases, each of which is decoded by a set of relays which check the reading and route the information to the appropriate set of rotary switches. There are three sets of rotary switches, one for the turret and one for each of the movements: their function being to store the next required movement. When the previous punch stroke has been completed, the three movements take place simultaneously under the control of the rotary switch sets and the associated motor control relays. The actual turret and table positions are fed into the rotary switch sets continuously from digitisers, whose function is to convert position to an electrical code with an accuracy of $\pm$ 0·01 in. As the desired position is approached, the motor speeds are reduced, and when the position signal from the digitiser coincides with the desired position, the corresponding drive is switched off and a brake applied. When all three movements have finished, a signal actuates the punch. Adequate interlocks and circuits are provided to minimise faulty operation of the system.

PUNCHED TAPE SYSTEM

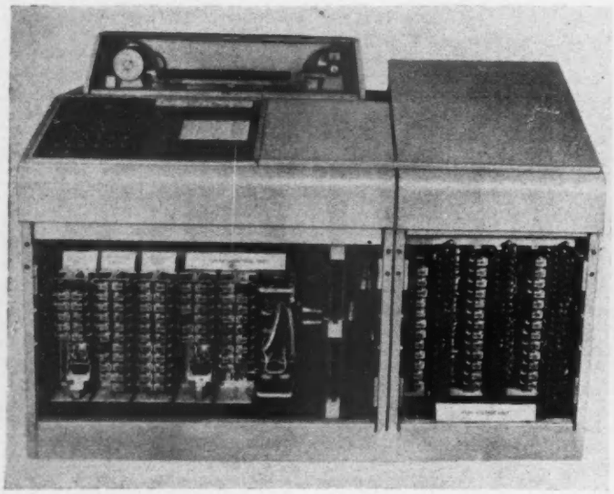
The tapes are produced on a Creed teleprinter which gives a red visual typewritten record with the punched tape as the byproduct. When subroutines are added or alterations are made to the master tape a Creed transmitter is utilised, the output of which is passed to the teleprinter, which then gives a black-printed record. By this means, information added from the teleprinter keyboard is distinguishable from that added by the transmitter, and a changeover from one to the other is very easily carried out.

The information required on the tape for setting the machine and actuating the punch ram consists of a turret movement code followed by two decimal digit codes, a Y movement code followed by four decimal digits, an X movement code followed by five decimal digits, and the punch code. Each of these codes occupies one line across the tape and is made up of a combination of up to five holes. These combinations are grouped for easy recognition: a four-hole combination denotes a movement code, two holes denote a digit code, while a combination with an odd number of holes denotes a subsidiary operation such as an operator's instruction. These odd-number combinations are preceded by the letter code. The grouping provides a means of checking the movements and their digits while the tape is being read. The letter code cancels out the checking circuit when an odd number combination is read. One whole setting occupies 1½ in of tape, but should a movement not need to be altered, it is not punched into the tape a second time so that only the minimum amount of tape is employed.

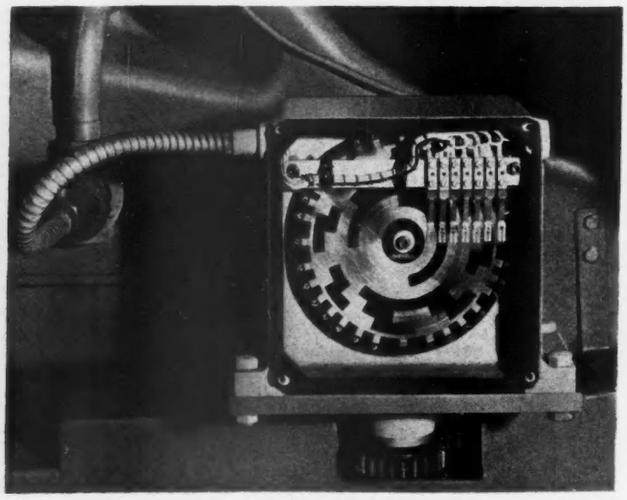
The panels produced on the press are punched



A Wiedemann turret press fitted with the automatic control system.



A front view of the control desk showing the relay arrangements.



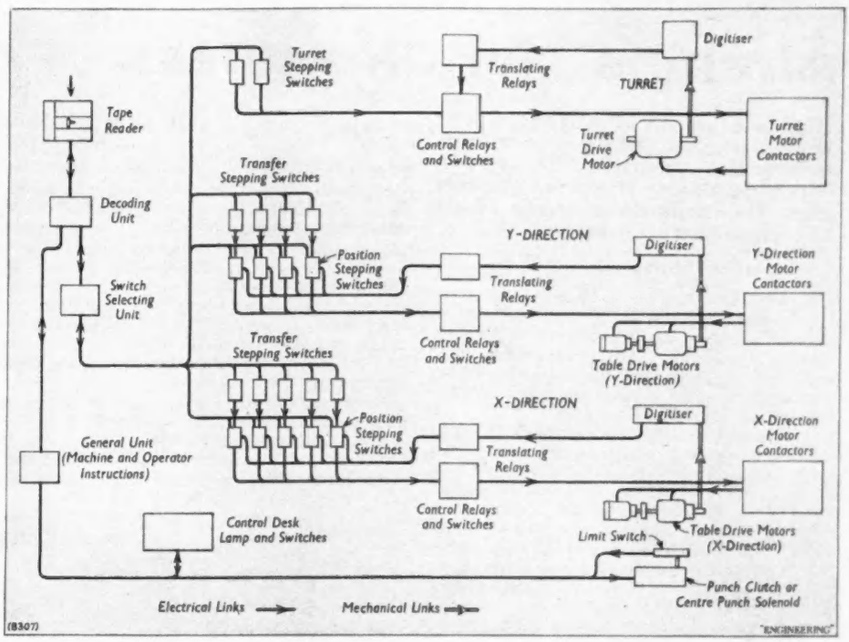
The turret digitiser mechanism.

with a standard series of apertures, but the position of these apertures may vary from panel to panel. Time can be saved by programming the punches required to make each aperture, taking the aperture's centre point as the datum, and then adding these individual programmes or subroutines into a master programme. When subroutines are added to the master programme in this way, they are preceded by subsidiary X and Y coordinates which are accepted by the control, and the X or Y coordinates which follow are added or subtracted to give the true position. When the aperture has been punched, zero subsidiary coordinates are inserted so that any subsequent reading is as programmed. This method can also be used to make small identical components from a single large sheet of metal.

The control system is not able to carry out all the duties formerly performed by the operator, such as removing scrap and moving the clamps along the table. The programme must, therefore, contain coded information to warn the operator that these tasks must be carried out. When this occurs the press is stopped automatically and the appropriate indication is given on the control panel.

Under automatic control, higher output has been achieved by reducing operational time and by minimising physical fatigue and time lost when an operator is away from his machine. This has resulted in a direct operational saving of 25 per cent in machine time, and a corresponding overall saving of 33⅓ per cent as the operator is able to perform other work while the machine is in operation. The use of subroutines by the programmer responsible for compiling the instructions has resulted in a saving in time of 70 per cent and has greatly reduced the mental fatigue encountered in performing this operation.

A further important advantage resulting from the introduction of automatic control is a reduction in labour turnover. Under manual conditions, operators are known to suffer from severe headaches due to the degree of concentration required and to the level of background noise. In consequence, requests for transfers to other machines are common and output varies considerably with different operators. With automatic control, full output can be achieved, without physical strain, by an unskilled operator after a training period of two or three days.



A simplified schematic diagram of the automatic control system.

Welding in Russia

A delegation from the British Electrical and Allied Manufacturers' Association has just returned from Russia where they interested themselves in welding. They visited a number of institutes and works and a shipyard. They report that the technological work of the institutes was excellent and, in particular, the applica- of theory to the development of welding techniques was outstanding.

Many semi-automatic processes had been devised to undertake duties covered by hand welding in the United Kingdom. These processes and the equipment itself seemed to be first rate, although the speed of welding was little faster than many hand welding techniques used here. The development of hand welding in the United Kingdom was undoubtedly ahead: particularly in the field of high current welding and in the use of iron powder loaded electrodes which, in many cases, gave a rate of productivity equal to, or better than, some of the semi-automatic processes.

In the field of fully automatic arc welding, their rate of progress was about equal to ours although they now make widespread use of electroslag welding: a process developed in the Paton Institute at Kiev which the delegation visited.

In the resistance welding field, practice had developed along similar lines to those in this country, although they seemed to lag slightly on high production special purpose machines. The number of large three-phase machines for welding light alloys was impressive and it was believed that the main application of these machines was in connection with rolling stock.

Interesting new techniques being developed included friction welding, semi-submerged arc welding of light alloys, and hand surfacing by submerged arc welding, with bead widths up to 3 in.

In spite of the volume of technological advance in welding, it appeared to the delegation that a number of industrial plants were still using old processes due to shortage of new equipment.

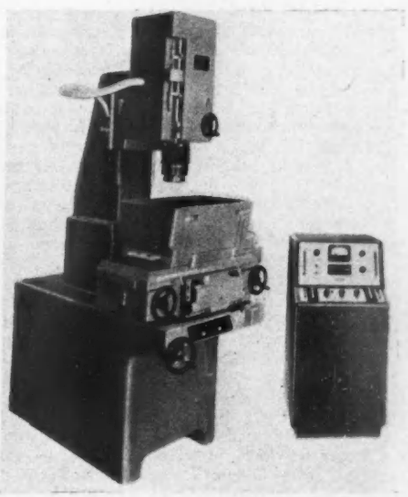
Combined Effort in Spark Erosion

A combined effort by Société Genevoise d'Instruments de Physique of Geneva, Switzerland, and AGIE Industrial Electronics Limited of Losone-Locarno, Switzerland, created a great deal of interest at the International Machine Tool Exhibition. Cooperation between the two companies has produced the SIP-AGIE spark erosion machine which combines the SIP 1H high precision optical jig boring machine with the AGIE spark eroding head.

The new machine represents a logical step in the development of spark erosion techniques. Certain types of eroders have been fitted with coordinate measuring systems for quite a time and the high accuracy of the jig borer provides a ready-made device for improving the accuracy.

A control console supplied with the equipment contains all the necessary elements for producing the electrical discharges and controlling the movements. It embodies two removable frames. The upper frame contains the generator and amplifier and on the lower frame the push buttons and selectors for engaging and regulating the rotation and the feed of the spindle are arranged.

The travel of the work table in both longitudinal and transverse directions is 8 in and the displacement of the table can be read to 0·0001 in on the micrometer dials—the guaranteed accuracy of all displacements of the work table being 0·00008 in. The work head travel is 10 in in the vertical direction and metal can be removed at a maximum rate of 0·02 cu. in per min.



The SIP-AGIE spark erosion machine and its accompanying control console. The machine is based on an optical jig boring machine.

Airships for Noiseless Feeder Service

High noise level may prevent the use of helicopters for inter-city rapid transport. Airships using thermal ascent can be noiseless, safe, and economically competitive.

By B. G. Bodroghy, D.I.C., B.A.Sc.

AIR TRANSPORT is never more than a few years behind the latest developments in aviation, but the methods of conveying passengers between airports and their destination is still in the dark ages. The anomaly between supersonic flight and agonising crawl will tend to increase in the coming years before noiseless supersonic vertical-take-off airliners become a reality.

It appears to take about ten years to apply military advances to civilian air transport. As vertical-take-off bombers and fighters are still only in the prototype stage, it may be expected that airliners by themselves will not eliminate the need for feeder transport for another 10 to 20 years. An intermediate method of feeder transport is urgently required to bridge a 20-year gap, and the long forgotten blimp or dirigible appears to offer the most promising solution.

Specifications can be drawn up easily for an improved system of feeder transport. Cost per passenger must not exceed the present charge for the bus ride to London Airport, or about 5*s* per trip. Time taken per trip must be reduced to 20 or 30 minutes including embarkation and disembarkation. The craft must operate from the centre of cities in any weather. Landing and take-off conditions must be acceptable to the inhabitants of cities and compatible with the operation of airports. The craft must be ready for commercial operation in a very few years, not decades. Capital investment must be sufficiently low for amortisation over 20 years. Finally, the system must be flexible enough to accommodate shifts in the traffic pattern.

The choice of transport quickly narrows to two forms: vertical take-off aircraft of various types, and rapid rail transport. Rail transport —subway or monorail—fits the specification in most respects but must be rejected on account of high capital cost and lack of flexibility. Taking London Airport as an example, the traffic may be distributed in varying proportions between tourists for the West End, holiday-bound Londoners from the suburbs, businessmen from the City, and a mixed bag of travellers from the Birmingham-Coventry conurbation. The distribution of travellers for each destination may show both a seasonal variation and a permanent shift over the 20-year period, something a railbound system can accommodate only at great expense.

VERTICAL TAKE-OFF MINUS NOISE

Lower initial cost and flexibility in operation are features of vertical-take-off craft. Three main types can be distinguished: rotating wing, jet supported, and lighter-than-air craft. Helicopters are in commercial operation and have been applied to scheduled airport feeder service in Belgium, Russia and the United States.

Jet supported craft (developments of "flying bedsteads") are now in an advanced prototype stage for military applications and may come into commercial use five to ten years from now. As the total lift is derived from the thrust of compact high-speed engines, these craft are characterised by a high noise level.

Helicopter noise has received considerable attention recently and was discussed in some detail in a recent article by P. H. Parkin, "Heliport Noises May be a Public Nuisance" (ENGINEERING, 25 Dec., 1959, p. 678). Present day helicopters operate at a noise level varying from 100 to 120 decibels depending on the type of engine used, but a 30-seat helicopter for feeder transport would have to rely on the noisier turbine engines. Based on Parkin's study and assuming that all London Airport terminal passengers—4 million in 1959—are transported by a 120 db, 30 passenger helicopter to the city's centre, a landing and take-off would occur every two minutes. The noise generated by these landings would cause objectionable interference with speech for 15 seconds in offices with closed single windows in an area of 5,000 ft diameter. In other words, voice communications would be impeded for at least one quarter of the time. Noise is one of the main reasons why helicopters are restricted in operating from city centres.

Noise reduction is still a young art and it is possible that great strides will be made in the future. But at the moment the elimination of turbine noise is a formidable task. The situation is typified by the concluding remark in the article "Aircraft Noise" which appeared in the *Bristol Siddeley Journal*, May, 1960. "It is not unreasonable to suppose that future designs of jet aircraft . . . will be as quiet if not quieter than piston engined aircraft . . ." The remark applies to pure jet engines and not helicopter turbines, and is quoted merely to indicate the modest targets—as yet unattained—set for noise reduction: the noise level of piston engines, or 90 to 100 db. Although below the threshold of discomfort, such noise is an objectionable disturbance in a city centre.

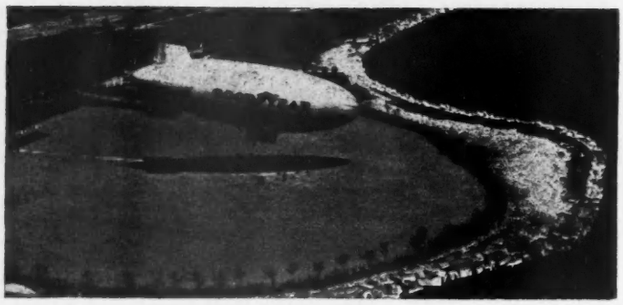


Fig. 1 Little space is needed to land an airship.

Noisiness is not inherent in turbine engines, it becomes a feature of aircraft only because of the requirement to release large amounts of energy in a very small and light engine. Smallness, lightness and high power rating are inherent in aircraft engines and make noise reduction such a headache, to which vertical-take-off craft contribute excessively. As there is little immediate hope of reducing the noise of highly rated engines to acceptable levels. one is led to examine the possibility of altogether reducing the power requirements of vertical-take-off craft. This may be done by airships.

Of the two main airship types—rigid and pressure ships—only the latter survives today under the popular name "blimp." Pressure airships comprise a flexible fabric bag filled with lifting gas at a pressure of 2 to 3 in of water which maintains the bag's shape in the fashion of an enormous rugby football. Expansion of the gas is allowed by means of internal airbags or ballonets which communicate with the atmosphere through small blowers supplying the required pressure.

At one time it was thought that there was an upper limit to the size of pressure airships. The Goodyear Aircraft Company have solved the problems of construction and have designed and built ships for the US Navy in sizes previously considered impossible.

From the point of view of feeder transport it is the airship's ability to make a powerless ascent that is of primary importance. This must be examined in greater detail. In order to rise an aircraft requires excess lift which may be derived from dynamic or static forces. The first involves engine noise, the second is silent. The traditional method of airship operation, evolved in the days when cheap hydrogen was used as lifting gas, consisted of alternately discharging ballast and lifting gas.

Today hydrogen is unacceptable owing to fire hazard, and helium is too expensive to be discharged at each trip, particularly when short flights are envisaged. US Naval practice is to fly the airships "heavy," that is, with negative buoyancy. A proper undercarriage is provided and the blimps take off and land like aeroplanes. Before airships can be used for inter-city travel, a different method of operation must be developed which requires neither the discharge of helium nor a lengthy runway.

Runways can be eliminated by using the helicopter principle to augment the lifting capacity of "heavy" airships. This has been done in the past using propellers that could be swung into a horizontal plane. Similar experiments are being carried out in the United States for transporting freight attached to a streamlined free balloon which is lifted and towed by a helicopter. (Balloon Supplants Helicopter's Lift, *Aviation Week*, 14 Dec., 1959.) The objection to this method of ascent is that noise is not eliminated, only reduced to a considerable extent.

BUOYANCY BY SUPERHEATING

The static buoyancy of a free balloon can be augmented by heating. The phenomenon is known as "superheating" in airship terminology, and was often experienced when radiant heat from the sun raised the gas temperature above ambient. Superheating was the dream of many early inventors for improving airship performance and is incorporated in hundreds of patents.

The technique has never been applied successfully for two reasons: during the heyday of airships, air conditioning techniques were still undeveloped and suitable equipment for heating large volumes of gas were not available. The other reason was that most inventors envisaged an airship that would carry the superheating equipment on board in order to maintain excess buoyancy for long periods. In the case of short-haul or feeder transport the superheating is only required to permit the initial ascent. As soon as the ship is well above the city the engines can be brought to full power to supplant lift and control the craft.

Ideally the excess buoyancy would be dissipated through heat loss during the short flight from city centre to airport and the ship would land with zero buoyancy or slightly "heavy." Heat transfer equipment need not be carried on board, but would be installed at all terminals and would function similarly to the air conditioning plant of a building.

A few rough calculations can be made to check the practicability of these suggestions. A 350,000 cu. ft airship with a gross lift of 10 tons, capable of transporting 30 passengers

with luggage and crew, is taken as standard. (The airship shown in Fig. 1 has 200,000 cu. ft capacity). The buoyancy of helium increases by about 0·2 per cent for each °F temperature difference, hence for a 30° F rise the airship would acquire a lifting force of about 1,300 lb.

To determine the heat input, it is necessary to obtain an estimate of heat losses. The mechanism of heat transfer in this case would be natural convection on the helium side and a combination of natural and forced convection on the air side, a notoriously difficult problem to solve for irregular shapes without model studies. Resorting to drastic simplification, assuming that the ship has the shape of a long horizontal cylinder, with constant surface temperature, and still air, the heat transfer coefficient lies between 0·6 and 1·0 Btu per sq. ft hr °F, using the methods of Marks' *Handbook of Mechanical Engineering* and *Heat Transmission*, by W. H. McAdams.

A third and completely independent method for checking the heat-transfer coefficient exists. In *Up Ship*, a book by C. F. Rosendahl, it is mentioned that on hot days 30° F superheat has been recorded on airships and 50° F on free balloons; that is 30° with forced, and 50° with only natural convection. The solar constant for a hot June day is about 444 Btu per hr sq. ft, and the absorptivity of aluminium paint 0·4. From this data the heat-transfer coefficient can be estimated assuming steady conditions: it works out to about 1·5.

Heat losses plus latent heat make up the total heat requirements, which are also time dependent. Assuming a 10 minute heating cycle, the total input may be of the order of 300,000 Btu (+ 50 − 00 per cent), or the equivalent of 14 lb of petrol. For comparison a Westland Westminster helicopter might require about 20 lb of fuel to climb to 1,000 ft.

The above figures are of necessity crude and are intended simply to indicate the orders of magnitude. But it may be concluded that " thermal ascent " of an airship is feasible, that it may be economically competitive with " powered ascents " particularly since cheap bunker oil can be used in the process, and that the required heating plant is no greater than a single large industrial unit-heater with a capacity of the order of 2 million Btu per hr. A silent airship for feeder transport is thus a definite possibility.

OPERATING CHARACTERISTICS

Taking the argument a step further, the operating characteristics of such a craft can be examined. Assuming that the ship manages to get into the air, it has to be propelled to its destination and landed. Fig. 2 shows a schematic layout for a proposed 375,000 cu. ft airship using two outboard mounted engines. A combined power of 1,000 h.p. would give the ship a cruising speed between 85 and 100 m.p.h., the speed of modern naval airships.

During flight there is strong forced cooling of the gas-bag and the helium temperature will drop rapidly. Assuming that the heat transfer coefficient is doubled, a 30° F temperature drop with a final approach temperature of 3° would take 11 minutes. The resulting loss of buoyancy is made up by dynamic lifting forces using the airship as an airfoil.

Landing is the most critical stage in operation. A landing platform may be provided on the Thames or on top of a tall building. In either case turbulent air conditions will exist even on calm sunny days, with violent gusts on windy days. Rosendahl, in his book *Up Ship*, dismisses the possibility of landing airships in city centres on account of high air turbulence. But the airship can be provided with means of developing thrust in three dimensions at short notice in order to overcome the effect of gusts.

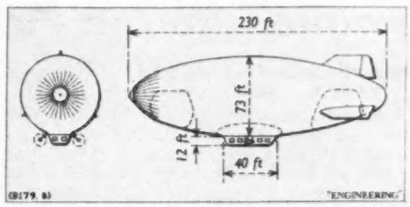


Fig. 2 Schematic arrangement of airship.

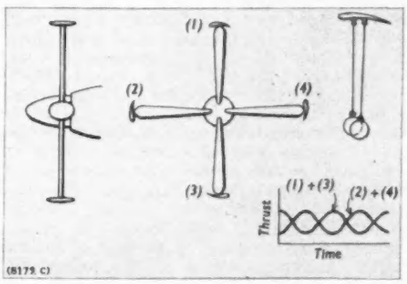


Fig. 3 Special propeller permits lateral control.

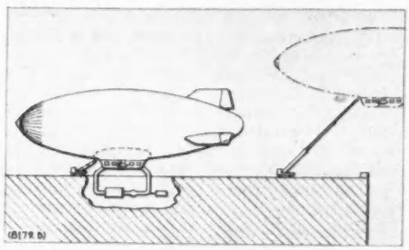


Fig. 4 Mechanised ground-handling reduces costs.

Reversible propellers can only provide thrust fore and aft, and the process of tilting and turning the engines involves inertia forces far too great for rapid control. An auxiliary propeller could be mounted on the engine nacelle, with axis perpendicular to the main propeller axis and rotatable about it. A suitable clutch or fluid coupling could disconnect the auxiliary propeller when cruising at high altitude.

The disadvantage of the method is mechanical complication and slow response as a result of gyroscopic effects. Large deflectors for the propeller stream could also be used, but suffer from the disadvantage of becoming ineffective when the propeller thrust is reversed. Fig. 3 shows an alternative that offers constant availability, rapid response, and relatively simple mechanical arrangement, but reduces the propulsion efficiency during cruising.

Small airfoils can be mounted on the tips of a four-bladed propeller, hinged with axes parallel to the propeller shaft. An additional link is provided for the cyclic control of the tipfoil's angle of incidence. The centric end of the control link follows a stationary near-circular cam of variable eccentricity housed in the hollow propeller shaft. By altering the direction and magnitude of the cam's eccentricity the direction and magnitude of the total lateral thrust from the tipfoils can be controlled. The cam profile can be shaped to give approximately sinusoidal net thrust variation from each blade in order to eliminate vibration. The tipfoils are lentil shaped so that alteration or reversal of propeller pitch would leave the aerodynamic performance of the tipfoils relatively unaffected.

Designing the tipfoils to absorb half-engine power at maximum thrust (leaving the other half for fore-and-aft control) a typical arrangement for a 1,000 horse-power installation would deliver a maximum lateral thrust of some 3,000 lb. Whirling around the tipfoils, whether lateral thrust is required or not, will cause a permanent power loss even though the angle of incidence is reduced to zero. Neglecting increased forward drag, the loss would be about 125 h.p. for the two engines, or 12·5 per cent of rated output.

SAFETY AT LOW COST

It is possible to design a craft that will operate safely and silently from city centres, using an airship hull in combination with the techniques of " superheat " and three-dimensional control discussed above. The low altitude noise of such craft would come from engines operating intermittently at half capacity during landing manoeuvres. If such noise is acceptable for longer periods, the elaborations necessary for superheating can be eliminated. It is difficult to estimate the cost of such craft, but a useful attempt can be made in the following manner.

The cost of a 12 passenger Sikorsky S-58 helicopter (identical with the Westminster Whirlwind) is $250,000. The power plant, control equipment and instrumentation of this helicopter is comparable to the requirements of the airship design. It could be reasonably assumed that the cost of one S-58 plus the cost of a gas-bag and filling of helium would be of the right order of magnitude. A gasbag would be about $70,000; while the filling of helium—at $18 to $22 per 1,000 cu. ft—would be $8,000, giving a total of perhaps $350,000 for a 30 passenger craft in series production. Helium losses would amount to about 2 per cent per month, or $150, while other operating expenses should not differ much from that of a helicopter.

Ground handling of airships would have to be completely mechanical. A hydraulically driven telescopic mooring mast mounted on a heavy flat truck could land the ship on a small platform, as shown in Fig. 4, with the minimum of ground personnel. The ship would moor on a fully extended mast at a safe height and be hauled down with engines shut off. Overload valves in the mast's hydraulic system could be used to avoid puncturing the gasbag should the ship be thrown against the mast by a sudden gust.

The airship would be as safe to operate as a helicopter. Both craft can be landed safely after complete engine failure, but both have a dangerous zone of operation near ground level. An airship can also be handled as a free-balloon in an emergency to avoid landing on high tension wires or tall buildings. Under emergency conditions, the craft's altitude is controlled by alternately discharging lifting gas or ballast. The latter may be fuel left in the tanks or luggage carried on board. Two halves of a rigid airship of the US Navy were once free-ballooned to safety after the ship broke up in mid-air.

Airships are the only vertical-take-off craft that can be operated at a sufficiently low noise level to be tolerated by the inhabitants of a city. If the capital cost of a rapid railway system cannot be justified, airships may be the only answer to the problem of traffic between city centres and busy airports. Airships can fulfil this task because design and operating experience have been accumulated during the past. Only adaptation of available knowledge is required, not the solution of problems which have refused to yield to persistent assaults in the past.

Comparison of Vertical-Take-Off Craft Performance

Designation	S-58, or Westland Whirlwind	Feeder Airship	Westland Westminster
Power plant	1 × 1,525 h.p. piston	2 × 600 h.p. piston	2 × 2,800 h.p. turbine
Accommodation	Crew 2; passengers 12	Crew 2; passengers 30	Crew 2; passengers 40
Weight empty	7,560 lb	15,000 lb	21,250 lb
Disposable weight	5,440 lb	7,600 lb	9,750 lb
Loaded weight	13,000 lb	22,400 lb	33,000 lb
Cruising speed	100 m.p.h.	85 to 100 m.p.h.	150 m.p.h.
Vertical climb	600 ft per min	600 ft per min*	600 ft per min
Maximum climb	1,150 ft per min	1,500 ft per min**	2,000 ft per min
Range	190 miles	200 miles	150 miles
Cost	$250,000	$350,000	—

* Silent. ** Augmented by engine power.

On the Shelf

By Frank H. Smith

How aesthetically satisfying is one expected to find a technical book? I notice that even one of the oldest and largest publishers now dishes out a book—admittedly a translation—in some sort of photoreproduction of a typescript where the lines are not even justified. Of course I know nothing of costs and that, I am sure, is the excuse. But at 58*s* I feel that something better than this should be offered. I wonder how it would have turned out if printed but in paper covers? The buyer could at least have his own boards put on if he did not like the binding, but about the type one can do nothing. Mind you, it is extremely clear and readable. All part of the rat race, I suppose.

I don't know about straws showing which way the wind blows or even if the proverb is applicable but it *is* a sign of the times that the College of Aeronautics (Cranfield, Bletchley, Bucks) issues a booklet on its (and entitled) "Course in Space Technology." Prerequisites are an equivalent of an honours degree (British, too—none of your American Masters in Chiropody) and an understanding of written and spoken English.

Dated June, 1960, there is a second supplement to the main catalogue of the Central Film Library (Government Building, Bromyard Avenue, London, W3). I wonder if these people should try to be clever over their titles? Even a literally correct title such as *Tractor Follies* could be misleading (no legs—only tracks) and as for *Riding on Air*, who would suspect that that was about bicycles?

Anybody who reads the ICI adverts must realise that this year the Royal Society is celebrating something. To mark it, the Society is publishing *The Royal Society and its Founders*, edited by Sir Harold Hartley. It comprises biographies of 21 early Fellows, including the 12 Founders. For this piece of real history the price is 35*s* or, since Americans will surely grab such a valuable piece of biography, six dollars.

The British Association (still determined to make us all scientists) has collaborated in the preparation of a book called *Annual Science Survey* which Vista Books (161 Fleet Street, London, EC4) are doing at 26*s* 9*d* (unless you are a British Ass. member when it is 21*s* prepublication but you are too late anyway). Space and the atomicity of the present day are, of course, well to the fore.

Europa Publications (18 Bedford Square, London, WC1) are determined that I shall tell you about *The International Who's Who 1960*. They sent me three separate and identically addressed envelopes. It is the 24th edition, has about 1,050 pages and costs £6 10*s*. The specimen page runs from Ranasinha to Rasmussen, covers two Randalls and Ras Imru Haile Selassie, who is *not* the Emperor.

If any of you librarians feel that you might get a swifter service by dealing with an individual bookseller rather than a multiple concern (I'm not saying one way or the other) you may like to try H. C. Feldt of 44 Swan Lane, London, N20. He is registered with the Publishers' Association and since he is a one-man band you will always know whom to blame when things—if things—do not go right. But *don't* blame me.

Sweet and Maxwell (the law people at 11 New Fetter Lane, London, EC4) have caught the current bug and announce a Russian translation *Science and Technology in Contemporary War* by Major General Pokrovsky of the Soviet Army Engineering Technical Services.

The Times Bookshop (42 Wigmore Street, London, W1) have just opened a new technical books department on the first floor. I do not know how many storeys there are at 42 Wigmore Street so I will not make facetiousnesses about Top People and the first floor (it would be a bit strained anyway).

Pointers to the Future

Britannica Book of the Year, 1960. Encyclopaedia Britannica. (105*s*)

Each year a single volume is issued as a supplement to the *Encyclopaedia Britannica* brought up to date with articles recording the main events of the previous twelve months. Of the 422 contributions to this new volume dealing with 1959, 302 come from the United Kingdom and the Commonwealth, so that the character of the articles and their emphasis retains much of the historic associations of the *Encyclopaedia*. Memories are short in these crowded days when crises of one kind or another seem to have become a daily feature of existence and busy people will doubtless find this record of recent events in world affairs useful for reference on their shelves. This year the index covering the articles in the last ten volumes has been improved by including all the articles in previous volumes, irrespective of whether they are included in this volume, and indicating in heavy type the volume in which they are to be found.

For readers of ENGINEERING the articles concerned with statistics of population, agricultural production, industrial production, and world trade will have a special interest in showing recent trends as these statistics cover a range of years.

The article on engineering techniques deals briefly with some of the interesting developments in 1959, among them the use of computers and of models in engineering design, new systems of gearing and hydraulic drives, techniques for reducing the noise of machines and mechanisms, the Wankel rotary piston engine and the development of glass ceramics. Some of these are treated in more detail in individual articles which are pointers to the future in this period of rapid technical change associated with the vast expenditure on research and development.

In the field of energy the industrial recession halted the rise in consumption and the availability of abundant supplies of oil and natural gas from new oil fields at cheap prices in many parts of the world averted the recent anxiety about the availability of adequate supplies of energy which in the United Kingdom had led to an expansion of the nuclear reactor programme. The consumption of coal declined and large stores accumulated in Europe. With the revival of industrial activity energy demands are increasing again but the changing pattern of 1959 may well continue.

One new feature of importance is the attention that is now being paid to the cheaper transport of large blocks of energy for long distances, either as oil or natural gas in pipelines or as electricity by transmission at higher voltages or by direct-current cables. The first pipeline carrying coal as a slurry with water over one hundred miles has been opened in Ohio. In the USSR an underground pipeline to carry each year 15 million tons of oil 2,700 miles from Kuibyshev to Poland and the other satellite countries is under construction. In France, Germany and Italy pipelines are also being built and even in Britain with the shorter distances involved pipelines for oil products are being built or planned. The economy of transmitting energy in these ways compared with rail or road transport is certain to effect the pattern in the future.

In the United Kingdom gas has suffered from the competition from oil and electricity and a new move is being made by the construction of two plants for the complete gasification of coal on or near a coalfield to produce gas at high pressure for transmission in high-pressure mains. It may well be that the future of coal in countries without natural gas will depend on its gasification at the pithead and distribution in a high-pressure gas grid.

The steady increase of 6 to 7 per cent annually in the consumption of electricity continues. The large savings in the capital cost of modern conventional stations have set back the date at which nuclear stations are likely to be competitive and there are possible developments in the use of cheap industrial gas in power stations with pressurised combustion chambers on the lines of the Mercier equipression boiler. Much interest is directed to the possibilities of electricity generation by the magnetohydrodynamic technique which looks a better bet in the future than nuclear fusion.

In air transport the success of the Comet showed that jets can help to lower costs by offering more ton-miles per flying hour and the future clearly lies with this type of aircraft. In the United States rapid progress was made by helicopter airlines which carried 228,000 passengers and in the UK, Rotodyne services should be in operation by 1962.

In surface transport nuclear power has proved its value in submarines and will certainly be an important factor in naval vessels, whether it will be economical in the mercantile marine is much more doubtful. One new development that came into use in 1959 was the Dracone, the transport by water of liquids in nylon containers, which looks like having an important future. On land the electrification and dieselisation of railways is proceeding rapidly and is the established pattern for the future. In Britain the opening at long last of the first motorway M1 from London to Birmingham was a decisive event. The increase in the number of motor vehicles all over the world has made the motor-car industry a major factor in the economy of industrialised countries.

A feature of the steel industry is the increased use of tonnage oxygen in steel-making, which is likely to take the place of the openhearth furnace in the future and may affect the design of blast furnaces. The electric arc is also being applied more and more in steel furnaces. New methods of reducing iron ore are being actively developed and the steel industry may change its pattern in the future, gas replacing coke as a means of reducing iron ore. Engineering developments are constantly calling for new and improved materials, the use of beryllium in nuclear fuel elements being a good example. Metallurgical research is being geared up to meet these demands and the development of anti-creep materials may open up great possibilities for the gas turbine.

In control engineering rapid progress is being made in the automatic control of processes of all kinds, including the distant control of pipeline pumping stations, with large savings in cost. In 1959 the first chemical plant controlled entirely by a computer came into operation. The rate of development in this field will depend almost entirely on the savings to be made by automatic control and computers compared with the cost of the increasingly elaborate equipment involved. More and more physical techniques are now being applied to the rapid measurement of the factors to be controlled. The large output of transistors is an example of the speed with which the development of electronics is taking place, and now the maser—microwave amplification by stimulated emissions of radiation—shows how some of the latest refinements of physical research have been put to practical use. The maser should have a great future in the communications field via signals reflected from satellites. The automatic control of machine tools has been a feature of 1959 and new systems for automatic positioning and the continuous control of movements will become of great practical importance.

In 1959 world agriculture production for the first time in recent years increased more rapidly than population, but still lack of adequate food supplies is the major need of many countries including India. Consequently the demands for fertilisers, insecticides, weed killers and improved strains of seed are bound to rise together with the engineering extensions of irrigation works. One feature of 1959 was the improvement of implements for mechanised farming and this will certainly continue.

Chemicals were one of the growth industries of 1959 with increases in the production of

plastics, man-made fibres, artificial rubber and many other synthetic products based mainly on petrochemicals. However, micro-organisms are a strong competitor in certain fields, such as antibiotics and brewing, and the development of the more economical continuous methods of fermentation, now in infancy, in place of batch processes, will strengthen their future position.

These are a few examples of the technological advances of 1959 described in *Britannica* which are pointers to the future.

HAROLD HARTLEY

Three Hundred Years of Scientific Communion

The Royal Society: Its Origins and Founders. Edited by SIR HAROLD HARTLEY. *The Royal Society.* (35*s*)

Gresham College and the Royal Society. By SIR HAROLD HARTLEY and SIR CYRIL HINSHELWOOD. *The Royal Society.* (*For private circulation*)

A Brief History of the Royal Society. By E. N. DA C. ANDRADE. *The Royal Society.* (10*s* 6*d*)

In commemorating the tercentenary of its foundation the Royal Society has published three books. The first, which is concerned with its origins and founders, opens with an introductory chapter by Douglas McKie, professor of the history and philosophy of science in the University of London. This chapter is followed by a series of articles, each on a founder or early member, by an author with special knowledge of the field in which the subject made his notable contribution. These articles are of great interest, but it would be impossible here to summarise 20 already condensed biographies. Portraits where available are reproduced. This book will be indispensable to all future students of the history of seventeenth century science. It is clearly written, excellently produced, well indexed and fully documented.

Professor McKie, and the authors of the little book on Gresham College appear to have cleared up the misconceptions and uncertainties as to what actually happened between 1645 and 1660 leading to the foundation of the Royal Society in the latter year. Gresham College was founded in 1597 in a building, formerly the residence of Sir Thomas Gresham (1519-79) and was subsidised in accordance with his will from the income of the Royal Exchange, which he also founded. Seven professors were appointed to teach divinity, geometry, astronomy, physics, law, rhetoric and music. About the year 1645 the lecture rooms became the meeting ground for a group of philosophical, or as we should say scientific inquirers and so remained throughout the Civil War and the Commonwealth.

Between 1648 and 1651 a parliamentary purge at Oxford University left vacancies that several of these inquirers were called upon to fill. John Wilkins became Master of Wadham and threw open his rooms to a group that included in due course Christopher Wren, Robert Boyle and others. In 1657 Wren was appointed professor of astronomy at Gresham College. In 1659 Wilkins went to Cambridge.

With the Restoration in 1660 several Royalists joined the London group. On 28 November of that year at Gresham College a resolution taken by 12 persons constituted them the founder members of what was to be known as the Royal Society. Five had been Royalists; three had served the Parliament. Four were resident professors of Gresham College. Five had taught in the universities of either Oxford or Cambridge, though the universities as such gave little support to the study of "experimental philosophy," for which object the new society was constituted.

The new body became The Royal Society when Charles II granted its first charter in July, 1662. A year later, a second Royal Charter gave its name as " The Royal Society of London for improving Natural Knowledge," with a grant of arms and the present from His Majesty of the mace that still adorns the table at formal sessions.

Except for a break after the Great Fire of 1666, when the Royal Exchange members who had lost their own building temporarily took over Gresham College, the College was the home of the Royal Society until 1710. The College building became dilapidated and in 1768 was sold for its site value. The College did not acquire a permanent home until 1842, on the site it still holds; but the present building at the corner of Gresham and Basinghall Streets dates from 1912.

Professor Andrade's book is authoritative on matters of fact, but popular in style. It contains ten excellent portraits and four plates reproducing signatures and title pages. It brings the history of the Royal Society down to the present day. Consisting of straightforward narrative it does not need either index or bibliography. It deserves to be, and should be, read by all who are interested in the place held by science in modern life and how it came about. The Society was always short of money and for many years was too ready to accept fellows for their rank and subscription however slight their interest in science. But there was always the authentic nucleus

Sir Isaac Newton was president from 1703 to 1727; Sir Joseph Banks held the chair for the much longer period from 1778 to 1820. By that latter date other societies had been founded: the Linnean (1788), the Royal College of Surgeons (1800), the Geological Society (1807), and the Royal Astronomical (1820), and the Royal Society was severely criticised because only one fellow in six ever contributed to the *Transactions*.

In 1847 new statutes were introduced limiting admission. The annual intake now (1960) must not exceed 25 fellows, though applicants number about 300.

The Society appoints visitors and directors to the Royal Observatory; it collaborated with the Government in 1901 in founding the National Physical Laboratory, over which it still exercises ultimate control; it serves as the official representative of the British Government on various international bodies; it administers bequests amounting to £35,000 annually, and grants from Parliamentary Votes of £130,000. The Royal Society remains nevertheless, in the British tradition, an autonomous self-perpetuating body.

When the Royal Society was founded the only engineering work of any magnitude that was in progress was that of river improvement and fen drainage. Then, and for long afterwards, engineering was an art that owed nothing to the study of natural philosophy. When, in the second half of the 18th century civil engineering began to approach the status of a profession, the Royal Society was not slow to honour its leading practitioners. Between 1753, when John Smeaton was elected F.R.S., and 1798 when John Rennie joined, 12 other members of the Smeatonian Society of Civil Engineers were accepted as fellows. Many engineers were accepted in the first half of the 19th century, but thereafter the tendency for engineering to break up into specialised branches and the operation of the Royal Society's 1847 statutes have rendered their admission rare. While it lasted, however, the cross-fertilisation of science and industry was all to the good. It still is, but has to be pursued by other means than by common membership of the Royal Society.

S. B. HAMILTON

Rules and Tools for Navigating Blind

Radar and Collision: A Handbook for Mariners. By L. OUDET. *Hollis and Carter.* (15*s*)

Few readers will be unaware that the introduction of radar at sea has given rise to some very serious problems. The disastrous collision between the Andrea Doria and Stockholm in 1956 for the first time focused world attention on this subject, although it had been engaging some of the best brains in the world of shipping, law, insurance and radar design ever since the end of the Second World War. The avoidance of collision at sea, and more particularly the role of radar when that threat exists in low or poor visibility is the subject of Commander Oudet's *Emploi du Radar pour prevenir des aborgages*, published in English under the title *Radar and Collision*. Described as a " Handbook for Mariners," the book is written primarily for the sailor and the author devotes little if any space to the technical aspects of radar. The mariner's point of view is clearly stated and the book describes how those at sea go about solving their problems with the equipment available today, thus providing a most useful operational background for engineers and technicians whose work and interest cover the marine equipment field.

The book is divided into two main parts, " Rules " and " Practice." In the former the information derived from radar is critically examined in the light of the International Regulations for Preventing Collision at Sea, and the limitations of radar information compared with visual sighting are brought out. Such knotty problems as the interpretation of " moderate speed " and of the all-important phrase in Rule 16b " the position of which is not ascertained " are thoroughly considered. The author, while seeking every method of making use of radar to gain time where no loss of safety is involved, nevertheless affirms " To apply the Regulations strictly is the only solution that can be relied on in all circumstances, even the gravest. A master who is in a hurry may be inclined to laugh at this principle and think that he can do a great deal better on his own; but a prudent man, who values safety more than the saving of time, will find in Rule 16 a safe and effective guide "; and later, " So long as a manoeuvre can be carried out in safety, it is obviously legitimate to do so, but when it involves risk, it is equally obvious that it must be rejected and the navigator must fall back on the solution provided by the Regulations; he must reduce his speed."

The second half of the book deals with the solution of the day-by-day problems of using radar at sea. Commander Oudet writes of his own conclusions based on experience in command of radar-fitted vessels, rather than as an editor of a textbook which must qualify for the approval of many individuals or authorities. He is therefore in a position to be positive in his conclusions and recommendations. He treats each type of meeting encountered in fog at sea and recommends a well-reasoned and logical course of action. To the armchair critic he may sometimes appear too bold and positive; perhaps the sailor will think rather that he suggests courses of action that are sound and well reasoned only in so far as the " existing circumstances " are described. One way or another, as Captain Wylie states in the fore-

Continued on next page.

word, Commander Oudet gives us all " furiously to think."

There is a clear distinction made between the circumstances in which disengagement is possible and those in which a reduction of speed, if necessary to zero, is the only safe course. " Rule 16b applies invariably at close range for there is no time to plan disengagement, carry it out, and check its efficacy. However imperative disengagement may seem, its success may be thwarted by the other ship; and if this happens it is essential to have a margin of safety. If the margin has already been reduced since the echo was first detected, or if there is risk that it may be in the course of disengagement, it is essential to stop immediately."

In the same vein the particular dangers inherent in end-on meetings and the difficulty of choosing safe and sure avoiding action are fully described. In a chapter on " Close Quarters," the effectiveness or otherwise of last-minute action is analysed, the risks being viewed in the light of speed and, in some detail, of aspect. The general part of the book is concluded with a radar code entitled "Application of the Regulations in Fog by Radar-Fitted Vessels." This concise summary of the principles brought out in the text is put forward in the hope that navigators will adopt it to increase the safety of their own methods, thereby indirectly contributing towards the international adoption of an agreed code.

The 20-page appendix, " Typical Accidents—The Moral," gives brief details of five collisions, including the disastrous encounter between Andrea Doria and Stockholm, together with the author's view of why they occurred and the lessons they teach. One wonders whether the translator of Commander Oudet should be congratulated for the apt names some of the vessels have been given to hide their real identities. " Doubtful," " Headstrong," " Carefree " and " Dreamer " certainly live up to their names.

The principles expounded in *Radar and Collision* concern the fundamental problem of avoiding collision in conditions of reduced visibility, a sphere in which the human element on the bridge may well continue to play the major part for many years to come, regardless of improvements in radar equipment. The extent of the responsibility carried by the captain of a ship navigating by radar in fog is clearly very considerable and there can be no doubt that equipment reliability of a very high order is essential to him. Indeed, in this book there is much food for thought for sailors and engineers alike.

H. L. A. Foy

New Books

Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy held in Geneva, September, 1958. Volume 9: Nuclear Power Plants, Part 2. *United Nations, Geneva; HM Stationery Office, London.* (125*s*)

This volume and its companion (volume 8) include all conference papers dealing with the overall design of power reactors, and operating experience. A variety of types is described: water-cooled, boiling water, organic-cooled, liquid-metal-cooled, homogeneous and others. Volume 9 is particularly concerned with concepts of future power plants and with conclusions drawn from present-day experimental power reactors.

Reinforced Concrete Reservoirs and Tanks. By W. S. Gray. 4th edition revised by G. P. Manning. *Concrete Publications Limited, 14 Dartmouth Street, London, SW1.* (12*s*)

The design and construction of plain and reinforced concrete reservoirs and tanks, swimming baths and pools, discussing various methods in detail, and giving the simplest solutions to different problems. This edition carries notes on the new BS Code of Practice (1960).

Chemins de Fer: Glossaire des Termes Ferroviaires, Français-Anglais, Allemand-Espagnol, Italien-Suédois. *Elsevier, Amsterdam; D. Van Nostrand, London.* (30*s*)

A six-language glossary of 1,995 railway terms arranged alphabetically by the French term, and with alphabetical indexes from the other five languages.

Polythene. Edited by A. Renfrew and Phillip Morgan. 2nd edition. *Iliffe.* (165*s*)

Only three years have elapsed since the first edition but rapid developments have dictated an increase of some 300 pages in this new edition. New material includes a major contribution on copolymers, and sections on vacuum forming, reprocessing and non-film packaging applications.

Civil Engineering Today. By Rolt Hammond. *Oxford University Press.* (21*s*)

A popular introduction to civil engineering, forming part of the *Pageant of Progress* series. Mr. Hammond deals simply but thoroughly with recent constructional work in many fields, well illustrated with examples and photographs.

Cours de Mécanique. By Henry Favre. 2e edition. Tome second: Dynamique des Corps Solides Rigides. *Editions Leemann SA, 20 Arbenzstrasse, Zurich.* (47·50 *SFrs*)

In this second volume of his mechanics course Professor Favre has presented the laws and formulae in such a form as to make them readily applicable to concrete examples, and each chapter is followed by a series of exercises. The new edition contains additions, particularly on Lagrange equations.

Mezhdunarodnii Geofizicheskii God: Informatsionnii Bulleten No. 8. *Izdatelstvo Akademii Nauk SSSR, Moscow.* (*Free of charge*)

The latest bulletin on Soviet contributions to the International Geophysical Year includes reports on programmes in geomagnetism, glaciology, oceanography and the ionosphere, and on the 3rd and 4th cruises of the *Vityaz*.

Effects of Nuclear Radiation on Men and Materials. By T. C. Helvey. *John Rider, New York; Chapman and Hall, London.* (15*s*)

An elementary summary of basic concepts of radiation and atomic physics, radiation effects on men and materials, and shielding design and construction. The author's underlying interest is in applications to the airborne reactor.

Television Explained. By W. E. Miller, revised by E. A. W. Spreadbury. 7th edition. *Iliffe.* (12*s* 6*d*)

A non-mathematical introduction to television, assuming a knowledge of sound radio, but no previous knowledge of television circuits. It is intended for students, radio service engineers, and " knowledgeable owners of television receivers."

Engineering Mathematics. By J. Blakey and M. Hutton. *Blackie.* (40*s*)

Based on Dr. Blakey's *University Mathematics*, but with the more theoretical chapters replaced by sections on numerical solution of equations, statistics, relaxation methods, and Laplace transformations. Intended to cover the mathematics needed for a degree in engineering at most universities.

British Chemical Plant, 1959. *British Chemical Plant Manufacturers Association, 14 Suffolk Street, London, SW1.* (*Free of charge*)

This directory has doubled its size since the war, and now covers the products of 248 member firms of the Association. The main body of the volume is made up of illustrated catalogue entries, with a classified index, and a list of names and addresses and agencies.

The Reviewers

Sir Harold Hartley, G.C.V.O., F.R.S., has played an active part in engineering research and development during the past 40 years. He has been particularly concerned with fuel and power, having served as chairman of the Fuel Research Board, the Electricity Supply Research Council, the International Executive Council of the World Power Conference and the OEEC Energy Commission. But he has also been active in other fields. From 1930 to 1945, he was vice-president and director of research of the LMS Railway, and in 1946 was appointed chairman of British European Airways Corporation, becoming chairman of British Overseas Airways Corporation in 1947. He has also been president of the British Association for the Advancement of Science and chairman of council, Duke of Edinburgh's Study Conference on Human Problems of Industrial Communities. He is a member and past-president of the Institution of Chemical Engineers and the Society of Instrument Technology, and is currently engaged as scientific adviser to Constructors John Brown Limited.

Dr. S. B. Hamilton, O.B.E., B.Sc. (Eng.), M.Sc., A.R.C.S., M.I.C.E., M.I.Struct.E., was president of the Newcomen Society from 1944 to 1946 and won the Dickinson Memorial Medal in 1958. He holds a Ph.D. in the history and philosophy of science. Dr. Hamilton was also president of the Institution of Structural Engineers from 1954 to 1955 and until retiring in 1959 served with the Building Research Station of DSIR.

Mr. H. L. A. Foy has been engaged for the last seven years in operational research on marine radar while serving with Decca Radar Limited. He wa previously a specialist navigating officer in the Royal Navy.

The Economics of Shipbuilding in the United Kingdom. By J. R. Parkinson. *Cambridge University Press.* (40*s*)

Written primarily for economists, but likely to be of interest to the shipbuilding industry, Mr. Parkinson's book describes the present state of the industry, the demand and supply of ships, and future prospects.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Instruments

Fuel Gauge. Firth Cleveland Instruments Ltd., Treforest, Pontypridd, Glam. The Pacitor aircraft fuel gauge, low voltage operation, no moving parts. Full set of units including water detector. Booklet.

Teleprinter. Creed and Co. Ltd., Telegraph House, Croydon. Model 75 teleprinter transmitter-receiver and receiver-only versions; the latter is suitable for airborne operations. Illustrated leaflets.

Sweep Generator. Rocke International Corp., 13 East 40th Street, New York, NY, USA. Jerrolds sweep generators; models covering 4 to 220 Mc/s. High output; portable. Leaflet.

Null-Balance Receivers. Firth Cleveland Instruments Ltd., Treforest Pontypridd, Glam. Gilbarco null-balance receivers primarily for electronic tank gauges. Leaflet.

Recording Controller. Ether Ltd., Tyburn Road, Birmingham 24. The Xactrol potentiometer recording controller series 200; single pen, 6 in chart, sensitivity 0·15 per cent of span. Leaflet.

Data Recording. Royston Instruments Ltd., Canada Road, Oyster Lane, Byfleet. Midas data recording system for flight parameters; recorders, playback, and ejection packs. Booklet gives details.

Marine Radar. Associated Electrical Industries Ltd., Electronic Apparatus Division, Blackbird Road, Leicester. " Escort " marine radar system; chart plan, true course displays. Brochure 4231-71 gives all particulars.

Air Traffic Control. General Precision Systems Ltd., 54-58 Uxbridge Road, Ealing, London, W5. A fully illustrated brochure in English and French of the air traffic control system developed by the American company for experimental use at Atlantic City.

Marketing

Aluminium and America at Milan Triennale

ASKING a designer to put together a home which shows original uses of aluminium in a residential structure, represents the American way of family life and is able to withstand the daily inspection of thousands of visitors could perhaps be called cruelty to designers.

The Californian designer, John I. Matthias, has contrived to satisfy all three in a stimulating "home structure" which is the setting for the United States exhibit at the International Design Exposition which opened at Milan on 16 July.

The structure has been built by the ALUMINUM COMPANY OF AMERICA (ALCOA), using extruded aluminium structural members and the advanced Alcoa "Alply" sandwich panel for walls and roof. The home stands above ground on aluminium channels and is capable of being moved.

It was built, assembled and then taken down in Los Angeles before being shipped to Milan and has been erected in the park veside the Palazzo dell'Arte. When the Triennale ends in November the aluminium home will be taken apart and returned to the United States for exhibition there.

The INTERNATIONAL GENERAL ELECTRIC Company of America has provided kitchen equipment, air conditioning unit, washing machine with dryer and the television set.

Comet Orders and Deliveries now 51

In their third repeat order since deciding three years ago to buy six Comets BRITISH EUROPEAN AIRWAYS CORPORATION has decided to buy another Comet 4B jet airliner, bringing the future size of the BEA Comet 4B fleet to ten.

The BEA step is one more reflection of the increasing tendency among passengers to go by jet liners whenever they have the chance. The effect is a faster introduction of airline jet capacity than seemed likely even a few months ago.

The number of Comet 4, 4B and 4C aircraft ordered or delivered is now 51. More than half are for BOAC and BEA and the others have been spread over AEROLINAS ARGENTINAS, OLYMPIC AIRWAYS, EAST AFRICAN AIRWAYS, MEXICANA AIRLINES, UNITED ARAB AIRLINES (MISRAIR) and MIDDLE EAST AIRLINES.

Automatic Control Order in Zinc Smelting

The Industrial Weighing division of ELLIOTT Brothers, a company of the ELLIOTT-AUTOMATION group, has won a £90,000 order to make automatic control equipment for a new zinc smelting plant in France.

The new plant will be built at Noyelles-Godault, Northern France, and the control equipment will bring the total of recent contracts for zinc smelting control by Elliott equipment to more than £250,000.

Elliott's new methods in electronic weighing have within the past year been adopted in the steel industry, chocolate making, road stone blending, breakfast cereals, bread, asbestos and biscuit making.

Chrysler to Sell Perkins Diesels in US

The CHRYSLER CORPORATION of Detroit is to handle the sale of F. PERKINS' diesel engines in the United States and Canada.

The substantial reductions to be made in overheads by the use of diesel engines is one of the reasons behind the growing market in North America for Perkins diesels. For some two years there has been a close Perkins-Chrysler association in the US.

Numbers of Chrysler trucks made on both sides of the Atlantic have been powered by Perkins diesels, either as the original engine or as a replacement. The Chrysler distributive network will now be handling the Perkins' engines for industrial equipment, tractors, trucks and taxis, and for boats and agricultural machinery.

Perkins, a MASSEY-FERGUSON subsidiary, recently formed the Detroit subsidiary, PERKINS ENGINE COMPANY. This organisation will be responsible for contacts with US manufacturers and for the general development of North American possibilities.

Canadian Beavers for British Army

Later this year the British Army Air Corps will be taking delivery of the first of its 36 Canadian de Havilland Beaver aircraft.

The arrangements are a little complex. The main components of the de Havilland Beavers will be manufactured by the Canadian DE HAVILLAND COMPANY, in Toronto, and shipped to England. Then they will be assembled in the company's Chester factory, British equipment including radio and instruments being installed.

After test flying the delivery schedule extends well into 1961.

Canadian de Havilland have already built more than 1,500 Beavers, which is in effect a half-ton flying truck designed to operate from short strips of cleared land.

The Army Air Corps is to use the Beavers for liaison work and casualty evacuation where the airfield situation is unreliable. Equipment of the British Army with Beavers brings it further into line with other Beaver using NATO powers.

Anglo-Soviet Trade Could be Doubled

If Anglo-Russian trade ever goes along as fast as the talk about it then the advance should be meteoric.

In Moscow towards the end of last month M. Patolichev, the Minister of Foreign Trade, met visiting British businessmen. He told them that Russia could double her trade with Britain, and that would include substantial orders for engineering equipment.

Mr. Patolichev believes that trade between the two countries could be most conveniently carried on upon the basis of agreements running for between three and ten years.

The volume of Anglo-Russian trade was up by about a fifth last year but the frequently repeated Soviet view, argued again at the recent talks in London, is that the two-way trade, and particularly British orders in Russia, should be much greater than it is.

The British businessmen in Moscow were led by Mr. Harold Drayton. They proposed that a delegation of their Soviet opposite numbers should visit the United Kingdom later this year.

Maiden Flight of the New Dakota?

Already scheduled to take part in the 1961 summer operations of SKYWAYS and B.K.S. independent airlines, the Avro 748 made another step forward at Woodford, Cheshire, when its prototype made its maiden flight.

It is only a little over 17 months ago that the decision was confirmed to manufacture A. V. ROE's twin turboprop. The factors behind the expectation that the Avro 748 may prove the replacement to the most successful commercial aircraft ever produced—the Dakota—lie in the operating details. A. V. Roe estimate that the 748's operating costs can be as low as a penny a passenger mile, the lowest reached in modern transport aircraft.

The first version of the 748 is to be equipped with twin ROLLS-ROYCE Dart engines, each developing 1,600 s.h.p. and enabling the aircraft to cruise at around 265 m.p.h. This Series 1 type will carry 40 passengers.

For airlines who need an aircraft for ranges up to 900 miles and of higher speeds there is to be a Series 2 with developed Darts of greater power.

Buses for Scotland—Fire Engine to Hong Kong

Versatility is a notable virtue of LEYLAND MOTORS of Lancashire.

At the same time as they are preparing to fulfill a £150,000 order for 30 underfloor-engined Tiger Cub single deck coach chassis and 25 double deck bus chassis for W. ALEXANDER, of Falkirk, Scotland, the company has dispatched to Hong Kong Fire Brigade an appliance on a Leyland Beaver truck chassis.

Bus operators in England and Wales have placed orders with Leyland worth more than £500,000 in recent weeks. The buses for the Falkirk order are powered by 110 h.p. Leyland diesel engines.

The fire appliance, with a 100 ft fire escape, was built by DAVID HAYDON, of Birmingham. Weighing nearly 12 tons, it has an hydraulic Magirus turntable ladder. Arriving in Hong Kong early this month the appliance should be ready for action as soon as its fuel tanks have been filled.

Multi-purpose US Loader Now Built in Britain

The ALLIS-CHALMERS widely known TL-14 Tractoloader is now being made in Britain. The United States company's United Kingdom subsidiary, ALLIS-CHALMERS GREAT BRITAIN of Lincolnshire, is making the loader, which is known as the BTL-14D.

The Tractoloader is a four wheeled, rubber-tyred loader capable of fast digging, lifting, carrying and dumping, of soil, sand, gravel, coal, rock and so on. The loader is designed with reverse speeds 30 per cent higher than forward movement.

Power is from an AEC 87 h.p. diesel engine. While the standard bucket size is 1½ cu. yd, there are various buckets available, from 1 to 3 cu. yd.

The Allis-Chalmers main distributors are the MACKAY INDUSTRIAL EQUIPMENT company, of Feltham, Middlesex.

More Ships Ordering Sperry Equipment

The number of ships fitting SPERRY gyro compasses, gyropilots and other equipment is on the increase.

The company has announced that 58 vessels completed installation of their products, including in some cases the rudder angle indicator, in February and March of this year. The shipyards named in Sperry's list include a majority of overseas builders, ranging from KURE and MITSUBISHI to BURMEISTER & WAIN. The home yards number among them SWAN HUNTER and CAMMELL LAIRD.

Pigments Plant to Expand Production

The ACHESON DISPERSED PIGMENTS Company has outgrown the capacity of its plant at Dukinfield, Cheshire, in only a little over two years.

The demand for pigment master batches and concentrates for the plastics industry has been growing continuously, particularly from the polyethylene and polystyrene producers. This increase has come from overseas as well as United Kingdom manufacturers.

Extensions to the works in Cheshire will provide the extra capacity the company needs—but for more or less than another two years?

Man From the Pru With a Computer

An Orion Data Processing System has been ordered from FERRANTI by the PRUDENTIAL ASSURANCE Company.

The installation will cost £400,000 with its associated punched card equipment. Converting existing records to the new method and getting the equipment into full use is expected to take from two to three years.

When the electronic changeover is complete all the Pru's 1,250,000 ordinary branch policies will be on record on magnetic tape and the company will be able to process the complete file every day.

Aluminium Company Absorbed by Northrop

A large United States maker and distributor of aluminium building products with export markets in 20 countries has been bought out by the NORTHROP CORPORATION, of California.

The company is ACME METAL MOLDING, which has subsidiaries in Vancouver, Canada, and Dallas, Texas. Established for 53 years, Acme has pioneered a number of developments in aluminium extrusion and in aluminium use in constructional engineering. Its sales are around $5 million a year.

It counts complete store fronts, entrance and facade mouldings among its output. This step by Northrop is a further phase in the application of its diversification policy.

Machine Design for Postal Mechanisation

The Universal Postal Union's recent conference highlighted developments in this country in Post Office mechanisation.

INTERNATIONAL conferences on engineering topics can generally be relied upon to bring into prominence some new developments, and this is true in the case of the Universal Postal Union's Conference at Eastbourne. Apart from the opportunity the meeting provided for the Post Office to demonstrate its latest ideas and equipment, the delegates were also able to inspect up-to-date postal installations at Southampton and Luton. The eight firms forming MBPE (Manufacturers of British Postal Equipment), who have been collaborating with the Post Office in developing and producing the new equipment, staged an exhibition in conjunction with the conference.

SORTING EQUIPMENT

Sorting is perhaps the heart of any postal installation, since the quantity of mail handled depends essentially on the speed of sorting. It falls into two distinct classes, namely machines used for letter sorting and those for dealing with parcels and packets.

Letter Sorting.—The Thrissell Engineering Company have produced three successive types of letter sorting machine. The prototype was followed by two greatly improved versions, the Mark I (ENGNG., vol. 186, 1958, p. 243), and now the Mark II.

The action of all three types is similar in principle. The unsorted letters (which have previously been "faced", or arranged to face all the same way) are presented one at a time to the operator who selects the appropriate pigeon hole by pressing a combination of buttons. Each letter is in fact presented twice in viewing windows to assist the operator in maintaining accuracy, and the limiting speed factor is the rate at which he can read an address.

The Mark II is shown in Fig. 1, and it differs from the earlier model in two important respects: (1) The complex electronic system of the Mark I has been replaced by an electromechanical system, offering the same performance but simplifying maintenance.
(2) Larger letters will pass through the machine, 11 in by $5\frac{1}{2}$ in by $\frac{7}{32}$ in thick, compared with $7\frac{1}{4}$ in by $5\frac{1}{2}$ in by $\frac{3}{16}$ in thick in the Mark I.

While the letter feeding mechanism is completely different the manner of presentation to the operator is unaltered, and a skilled operator can deal with 85 letters per minute. Four or six sorting systems can be provided, and the anticipation feature has been retained whereby the machine rate can be exceeded for two consecutive keyings. Also retained are the cancel box for incorrectly directed letters, and box grouping for heavily loaded destinations.

The mail feed is arranged on the left side of the machine looking from the presentation end, giving maximum conveyor length and permitting feeding attention without clashing with letter box emptying. The 144 boxes are on the other side of the machine, permitting side-laying of the letter on the stamped edge; the letters are piled towards the front of the boxes. Conveyor operation is by a photo-controlled Renold Spragg clutch to give a more constant-level take-off.

The electromechanical memory system can accept information at intervals of 60 microseconds, and is arranged so that the letter is released simultaneously with the memory setting.

The vertical distributor section is located near the feed end; this simplifies the conveyor by deleting the lower run. It has a geometrically planned letter path to give a distinct pattern to the letter boxes, which can be represented by 34 diagonal lines. The diverters on these lines are solenoid operated and linked mechanically so that only 34 memories are required for the boxes instead of 144 as in the Mark I. The 12 by 12 keyboard is the same, but instead of the 144-valve matrix, translation is by electromechanical means.

The only electronic components used are jack-in circuits which can be held as spares and easily serviced.

PARCEL AND PACKET SORTING

Both Sovex and Vickers-Armstrongs have developed similar systems for parcel sorting. In each the parcels travel along a horizontal conveyor until they are diverted by controllable baffles which swing out along the conveyor. Sliding down the chutes the parcels then feed into chutes, each of which serves a sorting

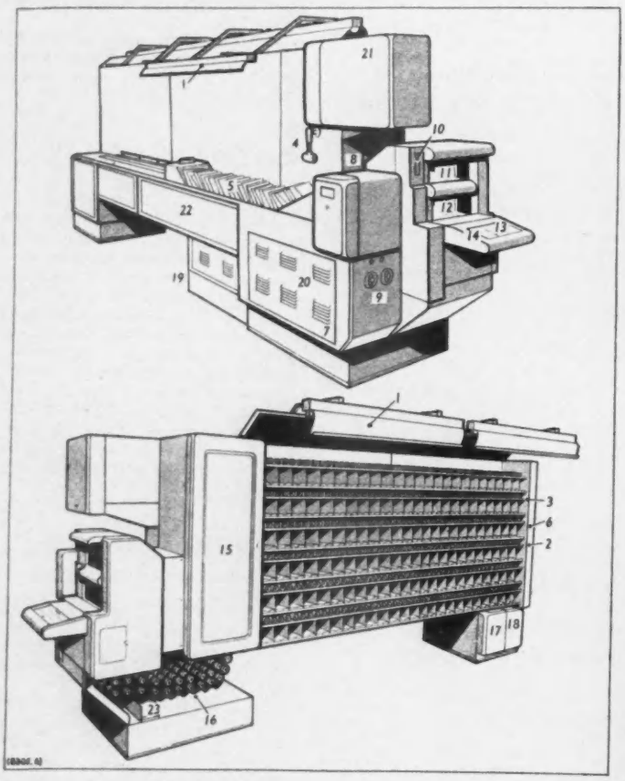


Fig. 1 Thrissell Mark II letter sorting machine.

1 Fluorescent machine lighting
2 Emergency stop button
3 Destination label holders
4 Feed conveyor drive photocell
5 Letter feed conveyor
6 Sorting plan indicator check
7 Lubrication pump
8 Letter pick-up
9 Master key switches
10 Illuminated alarm indicator
11 Main viewing window
12 Secondary viewing window
13 Coding keyboard
14 Main motor controls
15 Letter release mechanism
16 Operator identification printer
17 Library of four sorting variable change plugs
18 Clamping mechanism for changing plugs
19 Socket for letter jogger
20 Built-in main drive motor, vacuum pump and filters
21 Memory unit
22 Electrical console
23 Cancel box

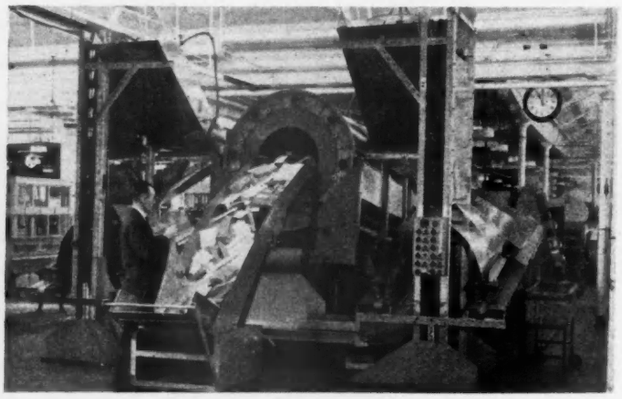


Fig. 2 Elliott segregating and grading machine. Mail is being fed into the drum, which is flanked by the two separating towers.

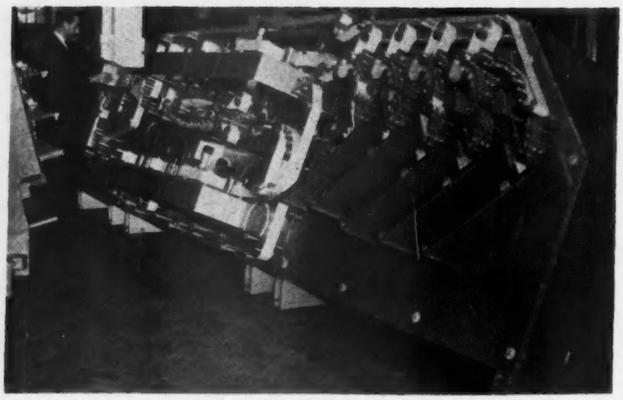
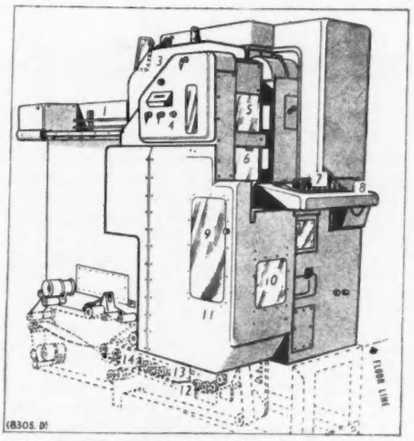


Fig. 3 Elliott letter facing machine, showing the working face. The stamp cancelling and stacking section is on the right.



1 Letter feed conveyor
2 Mirror
3 Letter pick-up
4 Panel incorporating master key switches and counter
5 Main viewing window
6 Secondary viewing window
7 Coding keyboard
8 Main motor controls
9 Letter release mechanism
10 Code printing unit
11 Letter release mechanism
12 Letter conveyor belt
13 Ultra violet lamp
14 Photo-multiplier check

Fig. 4 (left) Thrissel letter coding machine.

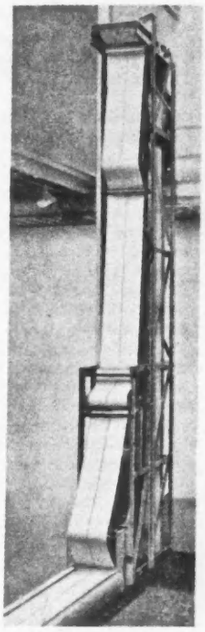


Fig. 5 (centre) Sovex vertical belt conveyor.

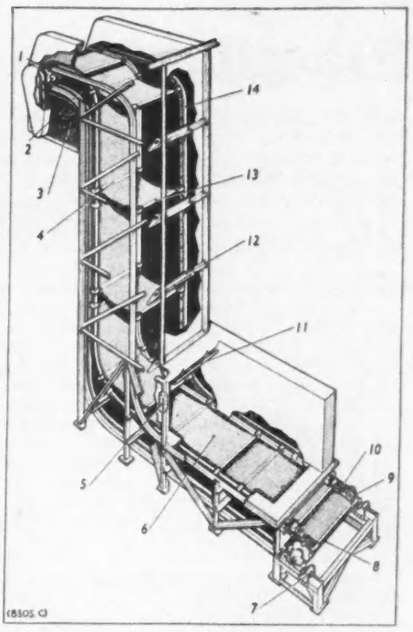


Fig. 6 (right) Vickers-Armstrongs vertical rising conveyor.

1 Drive shaft
2 Transition rollers
3 Main drive assembly
4 Leading-edge crossbar
5 Starter
6 Belt flap
7 Chain tensioner
8 Idler shaft assembly
9 Outer chain
10 Inner chain
11 Grab-rail emergency stop
12 Interceptor plate
13 Trailing edge crossbar
14 Chain guide

station. At each station is a sorter who reads each address and then presses a button appropriate to the parcel's destination. This button also initiates the travel mechanism.

The baffles are under the control of an operator whose job is to keep each sorter equally occupied.

For dealing with small parcels or packets Sovex have made certain improvements on earlier systems by grouping the primary sorting receptacles so as to save the sorters undue physical exertion.

Parcel and packet sorting systems as a whole are designed primarily to eliminate physical labour and risk of damage to parcels during sorting, rather than to replace the sorters by a fully or partially automated system.

SEGREGATION AND GRADING

Before being sorted, all the incoming mail must be segregated into letters, packets and parcels, and the letters stacked ready for handling by the facing equipment.

Elliott Brothers have been marketing segregating and grading machines for some years (ENGNG., Vol. 183, 1957, p. 695) and the equipment is illustrated in Fig. 2.

Mail feed can be either direct or by conveyor into the receiving hopper. Thence a rising conveyor feeds it into the segregating drum. This is inclined slightly downwards and rotates slowly. As it is formed of overlapping slats, normal letters and postcards escape through them. Thicker items move down the drum to fall out at the lower end, either to be dealt with at that point or conveyed away as required. The stream of letters falling from the drum is then passed by conveyor to the twin separating towers. Here they are divided into varying lengths by rollers, before passing to stepped conveyors where the widest ones are picked out. The sized piles are then ready for facing.

FACING

This is the term used for the task of taking letters from a random pile and turning them all the same way up. Elliott Brothers are producing a machine for this purpose (ENGNG., vol. 185, 1958, p. 62), illustrated in Fig. 3.

The machine can be activated in three very ingenious ways. Harrison and Sons have developed two successful methods of overprinting the stamps, first with electrically conductive graphite lines, and later with invisible ink containing a phosphor pigment. The third method of activation is by means of an optical scanner. This, though less infallible than the others, is necessary to detect untreated stamps or prepaid markings.

CODING

Experiments with different forms of coding addresses, with a view to dispensing entirely with the human element in letter sorting, has given rise to the development by the Post Office and the Thrissell Engineering Company of the machine shown in Fig. 4. The operator adds the required information to the letter using a typewriter, the letter being presented successively in two viewing windows in a similar manner to the letter sorting machines.

An electronic translator is used to translate a 5 or 6 digit code, representing any town or city in the UK, into a binary code. In the coding position each letter is side-layed to the stamp edge and clamped against a back plate. A strip of phosphorescent coated paper is fed across a gap in the back plate and the code bars. These are heated, and when the appropriate solenoids are energised the bars strike the coated paper and transfer the coating to the letter. In the discharge conveyor is an ultra-violet tube and photo-multiplier checking device, which ensures that the code has been clearly printed.

CONVEYING

The most interesting recent development in conveying techniques is undoubtedly that of the vertical rising conveyor. Both Sovex and Vickers-Armstrongs have each developed their own design, and of course these can be applied in many other different industries apart from handling post.

In the Sovex design, shown in Fig. 5, there are two smooth rising belts between which the mailbags (or other articles) are raised. To cause these articles to travel with the belts, pressure is applied to generate sufficient friction to prevent them from slipping, introduced by an inflated air-bag acting upon the belts.

To minimise wear, the air-bag is separated from the moving cover by a flexible curtain. The bag, curtain and both belts are contained in a rectangular mild steel duct. When an article passes between the two belts, the air-bag is correspondingly deformed and presses upon the article in an enveloping fashion, this deformation progressing up the bag as the article is raised. Meanwhile, an equal volume of air escapes from the bag, to be restored again as soon as the article emerges at the top by a forced draught fan. This pressurising system is designed to enable rapid variations in volume to occur with minimum variations in pressure.

The Vickers-Armstrongs design has only one rising belt. The articles to be lifted are carried by a series of flaps cut from a standard conveyor belt, as shown in Fig. 6. Each flap is supported between two crossbars, one at the leading edge and the other at the trailing edge. Each end of the trailing edge crossbar is connected to the outer of a pair of chains which run on each side of the conveyor, the other crossbar being connected to the inner chains.

On the horizontal, the trailing edge crossbar of one flap overlaps the leading edge of the next, the trailing edge crossbars crossing over the chains of the leading edge ones. On the vertical section the chains run in guides, which are pitched to cause the crossbar to form a rectangle when viewed in plan. The guides are close enough together to make the flaps sag in the form of a hammock. Articles are thus conveyed upwards on the flaps, and as the maximum height is reached the chains run around curved tracks and gradually spread the flaps until the horizontal run is again achieved. Since the entry and exit sections of the conveyor are horizontal, normal loading and discharging can be employed. The conveyor shown in Fig. 6 lifts 60 lb bags at a maximum speed of 200 ft per min, and a loading rate of 20 bags per min.

MISCELLANEOUS

Recent postal mechanisation trends involve far more new machines than those described. Among these may be mentioned the overhead chain conveyor (Vickers-Armstrongs), vending machines for stamps and Post Office stationery (Associated Automation and Setright Registers), packet stamping machine (Vickers-Armstrongs), and a mailbag cleaning machine (Sovex).

MBPE

The full names and addresses of the eight firms comprising the MBPE are as follows:

Elliott Brothers (London) Limited, Century Works, London, SE13.

Associated Automation Limited, 70 Dudden Hill Lane, London, NW10.

Vickers-Armstrongs (South Marston) Limited, South Marston, Swindon, Wiltshire.

Sovex Limited, St. John's Road, Erith, Kent.

The Thrissell Engineering Company Limited, Easton Road, Bristol 5.

Setright Registers Limited, Eastway Works, London, E9.

Harrison and Sons Limited, Hughenden Avenue, High Wycombe, Buckinghamshire.

Waterlow and Sons Limited, 26 Great Winchester Street, London, EC2.

Plastics Bearings for Greaseless Cars

A greaseless car will probably be on the market in a few years. Dry plastics bearings can now be used in most parts of a vehicle. Teflon is the outstanding material at present, but other plastics are coming.

PLASTICS bearings have been available for some time now, and they are developing rapidly. They hold out the prospect of a car that does not need regular greasing. A step towards this goal has been taken in the Triumph Herald, but as yet it has not been attained in full. Indeed, there is argument whether the production of a " greaseless " car is worthwhile, even if it is possible. It seems likely, however, that a vehicle which does not need greasing will be produced within a few years.

In a paper read before the National Lubricating Grease Institute, J. W. Lane and C. F. Foell pointed out that plastics linings in bearings are easily damaged by the entry of dirt. Unless the bearing can be effectively sealed, regular lubrication becomes necessary—to flush out dirt present and to act as a sealant. Bearings of nylon and other non-metallic materials have been used for some time in front suspension and steering linkages, for example, but have had to be lubricated in the normal way at regular intervals. The authors feel that development of a successful greaseless bearing depends on the production of a satisfactory greaseless seal. They also point out that the proposed new materials are more expensive than conventional ones. Also, the removal of the need for regular greasing might have disadvantages. When a mechanic sets about greasing a car he gets a good look at the parts not normally seen by the owner and often notices defects in their early stages. Unfortunate results could accompany the omission of this regular visual inspection, which is at present incidental to periodic greasing. If the inspection is still carried out one has not saved a great deal in maintenance costs by removing the need for greasing. However, the authors predict the greaseless car in three to five years.

MAINTENANCE COSTS

Whether or not reduction in maintenance costs is a valid argument, the greaseless car has considerable sales value, and the company producing the first model should gain considerable advantage over its competitors. Much research is therefore under way in the motor industry. It is, however, a time-consuming process, as the important property of each possible bearing material is its useful life.

Recent Russian work on nylon bearings for propeller shaft universal joints has been described in a paper by V. F. Platanov. Bench tests were made initially of various thermoplastic polyamide materials under loads up to 250 kg per sq. cm. Both wear rate and coefficient of friction of the plastics bearings were found to be considerably lower than those of bronze.

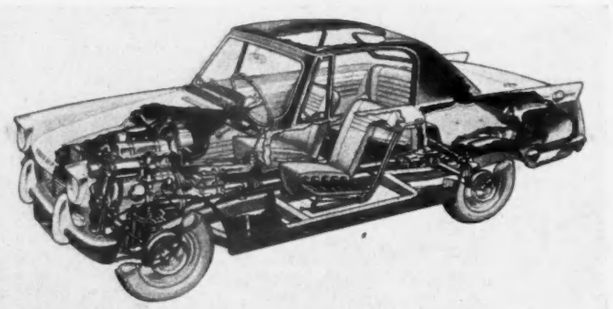
Slightly lower efficiency was noticed when plastics bearings were used in the universal joints of propeller shafts instead of needle bearings. However, tests carried out in various trucks over mixed road conditions showed that after 30,000 miles the plastics material with the best bench-test performance had negligible wear.

The most stable of the plastics at present available for bearing surfaces is Teflon ptfe fluorocarbon resin. It has a low coefficient of friction and can withstand high temperatures. Some taxicabs in Baltimore have been fitted with Teflon chassis bearings and have covered 50,000 miles without lubrication being necessary. Other possible bearing plastics are a couple of dozen varieties of nylon, Teflon FEP fluorocarbon resins, and Delrin acetal resins.

Plastics bearing design parallels that of conventional bearings. Just as no metal combination will suffice for all lubricated bearings, so no one plastics or composite is applicable to all dry bearing installations. The various types now available are discussed in a paper " New Plastics Bearing Materials," by R. E. Harmon (read before the annual meeting of the Society of Automative Engineers, Detroit).

There are several low sliding-speed applications of natural plastics in cars—ptfe fluorocarbon carburettor bearings for example. Examples of the use of nylon are found in door latches and speedometer gears, and ball and roller bearing retainers, cages, and spacers are in limited production. Several types of nylon bushings are in use in farm equipment.

Plastics in their natural state are limited by their high thermal expansion, poor heat conductivity, and low compressive strength. The thermal expansion of all types is about ten times that of metals, and so quite large clearances are required between shaft and bearing shell to avoid seizure. The low thermal conductivity of a plastic in its natural state means that heat generated at the rubbing face has only the metal shaft as a heat sink. The smallness of this heat sink limits the sliding velocity that the plastics can withstand.



The Triumph Herald design is a step towards the car that does not require regular greasing.

The load-carrying capacity of nylon and acetal resins is very good in the natural state. Ptfe and fep fluorocarbons are poor because they tend to cold flow under load unless they are in film form. Vast improvements in performance, in fact, seem possible by the use of very thin films, usually in metal composites. Ptfe fluorocarbon films under 0·0007 in in thickness can support 50,000 lb per sq. in at very low sliding velocity.

Addition of fillers to ptfe resin increases the load-carrying capacity, wear resistance, and to some extent the top temperature limit. Glass fibre was used initially and while it continues to be used, asbestos, molybdenum disulphide, carbon, bronze, iron oxide, etc., are also being used by various bearing manufacturers. In some cases wear resistance is increased by up to 500 per cent. Thermal expansion is reduced by 50 to 70 per cent by the addition of a filler. The coefficient of friction is raised by any filler, but generally remains insignificant.

Filled ptfe plastics have been used for piston rings in a power steering unit, and filled nylon piston rings have been used in farm equipment. The most wear resistant filled ptfe mixtures are more resistant than their nylon counterparts.

Plastics bearings reinforced with a wire screen or perforated metal will carry greater loads than natural state plastics or filled mixtures. Since the amount of plastics used is less for this type than an equivalent thickness of non-reinforced types, and since filled mixtures can be used as the impregnant, the problems of thermal expansion, heat conductivity, and compressive strength are still further reduced. The metal becomes the load bearing member with the plastics acting as the wear resistant surface.

One of the most widely used dry bearings is a composite consisting of a steel backing strip, a middle layer of porous bronze filled with a mixture of ptfe resin and lead powder, and an overlay of 0·001 in of the ptfe-lead mixture. The combination is more widely used in European cars than in American ones and applications include a propulsion shaft steady bushing, brake and clutch pedal assembly, throttle linkages, gear change mechanism, gearbox cross shaft, pendant pedals, and gear lever linkages. Commercial vehicle applications include a number of king pin assembly bushings and thrust washers, accelerator linkage bushings, and brake and clutch cross shaft bushings.

Each layer of the bearing has a specific purpose. The steel backing provides structural strength for high loading and for a tight interference fit. The impregnated bronze interlayer provides a conductive path to carry heat quickly from the bearing interface to the housing, and also acts as a reservoir for the ptfe mixture, to assure a constant smear of low-friction, low wear material on the bearing surface. The overlay applies a thin coating of the ptfe mixture to the mating surface and smooths over irrgeularities, so imparting low friction to the mating surface similar to the bearing shell.

The resulting composite provides the lowest thermal expansion and best heat conductivity of any dry bearing. It has the same order of high load carrying capacity as the woven fabric types. Unlike the other types mentioned above, it is suitable for high velocity service and can be used in cars at speeds up to 8,000 r.p.m. As far as wear is concerned, impregnated bronze bearings are characterised by early bedding-in wear followed by a very low wear rate. A typical wear rate is 4×10^{-7} in per hour. Installation clearances are recommended to be between zero and 0·003 in, on a diametral basis.

Best service life is obtained with mating surfaces that have a good finish—20 r.m.s. or lower; rougher surfaces reduce expected service life by their abrasive action. This point was borne out by the Russian experiments, in which it was found that provided the surface finish of the polyamide bearing was above a certain standard, the wear rate was not dependent on it.

Nylon changes dimensionally with moisture content and is the only one of the plastics mentioned that is so affected to any extent. In the Russian tests it was found that the mos moisture absorbent nylon investigated did no change its dimensions by more than 1 per cent when fully saturated, the bearing having a wal thickness/diameter ratio of 1 : 20. Further tests showed that bearing wall thicknesses of 0·8 to 1·5 mm had the greatest dimensional stability and were capable of withstanding the highest loads and sliding speeds.

The upper limit of service temperatures for the various materials have been reported as 250° F for nylon, 180° F for acetals, and 500° F for ptfe fluorocarbons. The FEP fluorocarbons temperature limit has not yet been well defined, but is expected to be about 350° F.

Preparing for Better Gas Supplies

Changes in the well established system of supplying consumer gas may be made in Britain, as they have elsewhere. If so, a number of technical problems will arise, particularly in metering the gas flow at the consumer end.

THERE is a possibility that natural gas, instead of coal gas, will some day be used extensively in this country. There are many problems to be overcome, both technical and economic, but a start has already been made by shipping liquid gas from America and there is still the outstanding possibility of being able to pipe gas directly from natural sources in the Sahara desert. In addition to this there is the much more likely possibility of a nation-wide change to a high-pressure grid system, which has been mooted for some time. Yet another possibility is that British gas may be purified and chemically changed. In any of these cases, a wholesale changeover would give rise to technical difficulties, some of which are common to all three propositions.

Seemingly small, but nevertheless quite acute, are the problems that would arise with any of these proposals in metering the gas flow at the consumer end. In the past, gas meters have always used leather diaphragms to measure flow quantities but, recent experience in America has shown that leather cannot be relied upon in these circumstances.

Since meters are used in their millions and must work at a high standard of accuracy and consistency, it is not surprising that a considerable amount of effort has been put into research for a new diaphragm material.

In this country one of the leading firms engaged on this work is the Metropolitan Leather Company, Great Harwood, Lancashire. This company has just opened a new research laboratory for large-scale testing and investigations into the physical and chemical properties of leather and various synthetic materials. Much of the equipment that has been installed is of unique design, and it is hoped that these facilities will enable materials to be tested so thoroughly that there will no longer be any need for field trials on new products.

AMERICAN EXPERIENCE

Many of the problems that may be experienced in this country, if and when a complete change is made in gas supplies, have been anticipated in the USA. When changing their domestic supply from coal to natural gas, the difficulties that were met in consumer metering were much the same as we can expect here if we either adopt natural gas or go over to a high-pressure system. Their supplies of coal gas had a relatively high humidity and were fairly rich in both saturated and unsaturated hydrocarbons. Among these volatile hydrocarbons were members of the benzol series which are extremely active solvents and which tend to be scrubbed from the coal gas by oils. The natural gas now being used is very dry and contains about 95 per cent methane, the remainder being the next highest members of the paraffin series in gaseous form.

During the life history of American gas meters, most of which used "bag" type leather diaphragms made from oiled sheepskins, the oil dressings had scrubbed hydrocarbons from the coal gas. The dressings had therefore become diluted, lost their viscosity and were partly drained from the leather. Thus diaphragms became effectively oiled with the dressing plus condensates, and sometimes mainly the latter. In areas where the gas supply had been very wet, water tended to be absorbed by the hydrophylic leather, either replacing the oil dressing with water or with an emulsion of oil, water and condensates. This effect was exaggerated in gas supplies containing small amounts of ammonia, which altered the pH of the leather and caused it to shrink. But, in spite of all this, some sort of equilibrium was always achieved when using coal gas, and meters functioned satisfactorily.

NO EQUILIBRIUM

However, when the Americans suddenly changed to natural gas, any semblance of equilibrium was upset. The dry gas acted like a dessicating agent and promptly removed the water and volatile hydrocarbons. The result was that the leather diaphragms lost nearly all their dressings, becoming dry and chemically hardened.

Because natural gas is so dry and contains no higher members of the various hydrocarbons, no powerful solvents of the benzol series and no injurious chemicals such as ammonia and cyanide, disc type leather diaphragms can function perfectly for almost indefinite periods. On the other hand, leather bag diaphragms, the type still preferred for American gas meters, have the inherent tendency to collapse on the top periphery. Consequently, bag type diphragms of coated cambric were eventually adopted. This material is much stiffer than leather and some flexing troubles were experienced. However, these were subsequently overcome by changing the profile and the method of forming.

A variety of materials and coatings were tried during these evolutionary stages but the materials that have emerged have proved satisfactory only with *natural gas* and bag type diaphragms. They cannot readily be adopted for disc type diaphragms, such as are commonly used in this country, nor do they lend themselves to use with other gases.

Although the changes that are anticipated for Britain may not be parallel to those in America, new makes of British gas are expected to have greater purity, lower humidity and lower content of both saturated and unsaturated hydrocarbons and so they will tend to have the same effects on leather diaphragms.

If a material could be found possessing the necessary physical properties plus the chemical inertness and stability against the effects of the gaseous constituents in the old and new makes of British gas, then the difficulties which might be expected to arise in Britain during a gas supply changeover period could be obviated.

An intense search for such a material has been made by the Metropolitan Leather Company for some years. Subsequent investigations have covered coatings and fabrics in many permutations, and many formulations of homogeneous moulded polymers. The method of mounting diaphragms has also received attention since

Continued at foot of next page

Techniques have been developed to measure gas meter "oscillations" electronically.

New methods of laboratory testing are expected to eliminate the need for field trials whenever changes are made in gas meter design.

Two Advances in Chemical Engineering

Unlike other DSIR units, the Warren Spring Laboratory is not tied to any one field of research. Their first annual report has just been published and contains the results of some important investigations, particularly in chemical engineering and process development.

DURING the first year of their existence, the Warren Spring Laboratory have confined their activities to four fields: atmospheric pollution, a subject in the forefront of national interest; mineral processing, including surface chemistry; process development, centering mainly on the Fischer-Tropsch process; and chemical engineering. Under the latter heading, some valuable work has been done on the efficiency of distillation and gas absorption plates.

DISTILLATION EFFICIENCY

At least three main factors govern the mass-transfer efficiency of a distillation plate: (1) the extent of the area of contact between gas and liquid in the foam produced on the plate (the gas liquid interface area), (2) the value of the mass transfer coefficients in the foam, and (3) the residence-time distribution of the liquids passing across the plate. These factors may themselves depend on the physical properties and the flow rates of the fluids, as well as on the geometry of the plate.

Methods have been devised at Warren Spring for measuring gas-liquid interface areas by observation of the optical reflectivity of the foams, a relation between these two factors having been established for model systems. Mass transfer coefficients have been measured by observing the rate at which dissolved gases are removed from a solvent air by passing through a distillation plate into the solution. Apparatus is also being developed to measure the residence-time distribution functions of liquids passing across a distillation plate by observing tracer substances which are injected into the flowing liquid. Finally, a method has been developed for measuring the density of foams by gamma ray absorption, in order to evaluate the mean size of bubbles on distillation and gas absorption plates.

A study is also being made of the mass-transfer behaviour of well defined swarms of bubbles passing through liquids, for comparison with the less well defined bubbles produced on distillation plates under commercial operating conditions.

In experiments with perforated distillation plates (sieve plates) it has been found that at a given rate of flow of vapour, the gas-liquid interface area varies with the geometry of the plate, while an increase in the rate of flow of vapour produces an increase in contact area. The mass-transfer coefficients in the liquid phase remain constant, however, and depend only on the physical properties of the fluids used.

When completed, these investigations should provide an accurate mathematical correlation that could be used for the precise design of large-scale equipment without the necessity for costly pilot plant studies.

IMPROVED HEAT TRANSFER

Another useful chemical engineering study that is being made at Warren Spring is in the filed of dropwise condensation promoters. The formation of a film of water on metal surfaces when steam condenses on the cooling tubes of heat exchange plant creates a barrier to the transfer of heat, and imposes a limit to the efficiency of the plant. On the other hand, if the steam condenses as drops which quickly roll off the metal surfaces, there is a marked improvement in the heat transfer and in the performance of the plant.

Certain hydrophobic organic compounds containing sulphur are known, which can temporarily render copper and brass surfaces water repellant, so promoting dropwise condensation. These compounds have been evaluated in tests made at the National Engineering Laboratory and found to give greatly improved heat transfer rates in condensers. A study is being made of the manner in which these promoters function, and particularly of the mechanism whereby they are attached to metal surfaces. The object of this is to develop compounds which would have a more permanent effect and be applicable to a wider range of metals.

In one investigation solutions of promoter have been agitated with copper micro-spheres, and the rate of adsorption of promoter on copper surfaces has been followed by an analysis of the solution, using an ultra violet spectrophotometer. It is concluded from the present results that attachment starts with an activation process in which chemical bonding of sulphur to copper is followed by a chain polymerisation process.

CATALYST RESEARCH

One of the most notable research projects being carried out at Warren Spring is on the Fischer-Tropsch process, by means of which liquid and gaseous fuels may be produced from low grade coal. In this process carbon monoxide and hydrogen, obtained by the gasification of coal, are caused to react at elevated temperatures and pressures in the presence of a catalyst. To synthesise oil, a liquid phase system is used in which the process gas is passed through a suspension of catalyst in oil. This method has several technical advantages over other known methods of synthesis and shows promise of being cheaper. Work is mainly being devoted to the development of iron catalysts possessing high activity and selectivity to products of maximum value, and the design of a suitable type of reaction vessel and method of operation.

Since the catalyst is so important in this work, and little is known of the effects of the physical properties of a catalyst on its activity, a full investigation is being made into the relationship between the physical properties and the chemical reactivity of iron oxide catalysts.

Progress has been made in the preparation of homogeneous mixtures of ferric oxide with di- and tetra-valent oxides in known crystalline forms. These will be used to determine the effects of defect structure on chemical reactivity. A series of mixed spinels (ferrites) has been prepared in order to study the effect on catalytic performance of the presence of cations other than iron in a crystalline phase that is relatively stable under synthesis conditions Considerable effort has been devoted to the design and building of equipment for this work, including the development of semi-micro units for testing catalysts at elevated pressures.

The study of the beneficial effect of gamma radiation on the activity of mill scale catalysts for synthesis has been continued. It has been found that the removal by evacuation at 150° C or above of adsorbed gases from the catalyst surface makes a catalyst susceptible to improvement by irradiation. In earlier experiments in which unsuccessful attempts were made to improve the activity of these catalysts for other, simpler, reactions (such as the oxidation of carbon monoxide), this high temperature degassing treatment was not used. If it had been used, it is believed that it would have made a significant difference to the results.

It has been found that certain iron oxide catalysts, after exposure to gamma radiation, emit low energy electrons at a lower-than-normal excitation level, when heated or exposed to light of certain wavelengths. An exploratory investigation has led to the tentative conclusion that the emission phenomenon requires the presence of a structure similar to that responsible for thermoluminescence in other materials,

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Concluding **Better Gas Supplies**

early research revealed that the mounting methods applicable to leather diaphragms were quite unsuitable for other materials, including polymers due to their different physical properties.

Designing a test rig for gas meter diaphragms poses an unusual problem. This is because, in the past, gas meters have been designed around the diaphragms and yet diaphragm performance has always been inferred from meter performance. The test rigs at the Metropolitan Leather Laboratory no longer rely on this method. They now have six rigs, five operating at room temperature and one at a temperature controllable up to 170° F. On these rigs, in each of which different gases are circulated, both individual diaphragms and gas meters are examined, the performance of both meter and diaphragm being assessed and checked regularly.

Specially designed diaphragm test units are installed which measure to a high degree of accuracy the total stroke and total displacement of single diaphragms. By this means, small changes in diaphragm performance can be measured and compared in the light of overall performance.

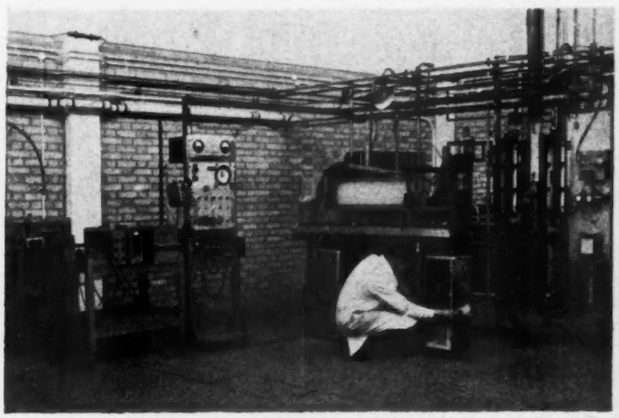
The gases currently being used for tests are: town's gas, humidified town's gas, benzolised town's gas, natural gas, liquid petroleum gas, and natural gas at 170° F. Natural gas tests can also be made at temperatures down to − 50° F; this being important when diaphragms are intended for export to places like Canada, where meters are often mounted outdoors and suffer temperatures ranging between − 50° F and 170° F.

BETTER METERS

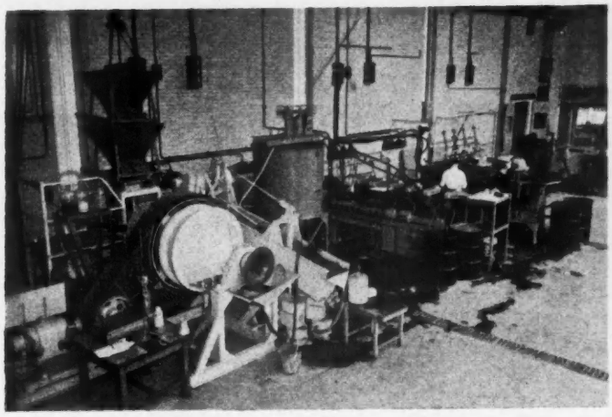
The gas industry has known for some time that the methods used to calibrate gas meters have been subject to a number of inherent errors arising from the difficulties of temperature and humidity control. Although the performance of gas meters is frequently reported to the second decimal place of percentage, the real reproducibility is of a much lower order of accuracy. Experiments in the new laboratory are planned to improve the accuracy of reproducibility and already an electronic oscillation gauge has been developed which will replace the liquid manometer. This latter instrument has been found to give incorrect readings due to the oscillation frequency of the fluid columns.

Since the elastometer materials being investigated in the laboratory have a physical "memory" characteristic and a tendency to permanent and semipermanent setting, a new apparatus has also been designed to examine the memory properties.

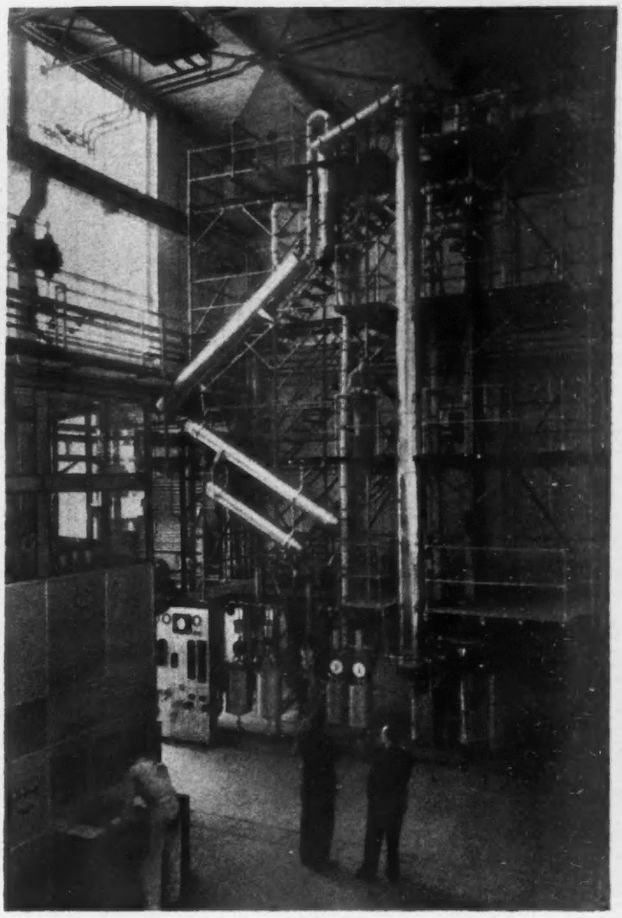
By running batteries of gas meters and single diaphragm test apparatus under closely controlled conditions in the new laboratory, it will be possible to gain statistically significant information on the real performance of new materials and of the meters fitted with them. This means that the gas industry will be in a position to accept or reject new diaphragm materials with a confidence based on well established data. This will save the time, money and uncertainty that have always been the penalty paid for relying upon field trials to prove new products.



Equipment is available for studying many aspects of mass transfer efficiency.



Several investigations are being made in the field of mineral processing, including a study of mineral particles in a high tension electric field.



A pilot-scale "slurry" plant for Fischer-Tropsch synthesis has successfully undergone preliminary trials.

that is, electrons in traps.

Although calculations indicate that oxygen ion vacancies might be provided by atomic displacements in sufficient concentration to account for the observed emission, the bulk of the evidence supports the view that radiation produces emission centres by excitation of electrons into existing oxygen ion vacancies.

GASIFICATION OF COAL

Investigations on bench-scale and pilot-scale plants are now being made to obtain the data necessary for the design and operation of a full-scale synthesis plant to process gas made by the direct gasification of coal. Gas so produced is likely to contain relatively high proportions (10 to 15 per cent) of carbon dioxide, and the effect of this constituent on the performance of catalysts is now being explored. Over the range 0·5 to 20 per cent, an increase in the carbon dioxide content of the process gas appears to have adverse effects on the activity and productivity of a catalyst, though no exact correlation has so far been established.

Operating conditions have a marked effect on the composition of the products, and it has been established that selectivity to give products of high molecular weight is improved by operation at low levels of conversion, and by recirculation of the gas.

Investigations aimed at solving the mechanical problems associated with an increase in the scale of the plant are being carried out on a pilot-scale Fischer-Tropsch reactor. This has had preliminary proving runs lasting several hundred hours and has proved satisfactory.

New Piezoelectric Materials Discovered

The discovery that zinc oxide and cadmium sulphide possess strong piezoelectric properties has just been announced. This discovery, which may lead to highly efficient electromechanical transducers for generating ultrasonic and radio frequencies, was recently made by research workers at the famous Bell Telephone Laboratories in the USA.

In order to demonstrate the piezoelectricity of zinc oxide, it had first to be doped " with lithium to neutralise the excess conductivity which, until now, has masked the effect. The degree of piezoelectricity exhibited by the doped zinc oxide is about four times that of quartz, while the cadmium sulphide is about twice as great. Confirming measurements have been made on vapour-grown cadmium sulphide and on zinc oxide grown by both vapour and flux techniques.

In piezoelectric materials, the application of mechanical stress results in the generation of a static electrical charge. Conversely, when an electrical field is applied to such a crystal, its physical shape changes in a manner dependent on the way that it has been cut. A radio frequency electrical signal can thus be applied to a piezoelectric crystal to generate mechanical vibrations at the same frequency. The best electromechanical transducers of this type are made from crystals which are strongly piezoelectric. Such materials exhibit a high electromechanical coupling constant.

Both zinc oxide and cadmium sulphide have long been recognised as *n*-type semiconductors. Zinc oxide in fact usually shows a room temperature resistivity of less than 1,000 ohm cm. This relatively low resistivity effectively cuts out all experimental evidence of piezoelectricity.

The investigations of the piezoelectric properties of these materials was made while studying some of their normal conductivity properties, especially the large magnitude of temperature dependence of the phonon drag effec t observed during thermoelectric power tests. A large piezoelectric constant seemed to give an explanation of these anomalies theoretically, but it had never been confirmed by experimental observation.

The conductivity of the zinc oxide was quenched by diffusing lithium atoms into the material, to act as acceptors for the excess electrons which were contributing to the conductivity. When this was done, the resistivity of the material was raised by a very large factor; from 10^3 ohm cm to 10^{12} ohm cm at room temperature.

Resonance-anti resonance measurements were made on vapour-phase grown needles and flux grown platelets of zinc oxide, and on the vapour phase grown cadmium sulphide. With dielectric constants of 8·2 and 9 for zinc oxide and cadmium sulphide respectively, electromechanical coupling coefficients were calculated to be approximately 0·4 for zinc oxide and 0·2 for cadmium sulphide, compared with 0·095 for quartz.

Swimming Pools in the Garden

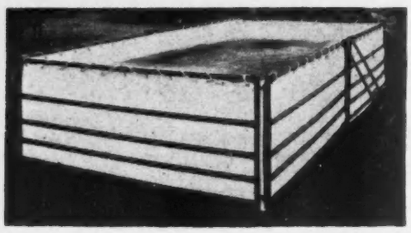
On a really hot day there is nothing quite to equal a dip in a pool. The sea is perhaps better but the number of people who can at a moment's notice plunge into it is limited. A pool in the garden is always ready.

The Swimette is a medium size example (it measures 14 ft by 7 ft by 2 ft 9 in deep) made of a Terylene-pvc laminate container supported by tubular steel frames. Erection is simple and no foundations are needed. For winter storage the frame folds up to 7 ft 6 in long by 1 ft thick. The standard range of Purley pools runs in sizes from 8 ft by 6 ft up to 41 ft by 25 ft by 3 ft deep; they also require only flat ground for erection without foundations, and like the Swimette they can be folded up for winter storage. The construction is a timber frame with an outer covering of Douglas fir plywood. Lindemann jointing is used. The box section construction allows unit extensions to be added in either direction. The plastics liner is clamped under the seating edge, and has safety ropes let in. The firm can also supply filtration and heating and purifying plant for permanent installations.

For permanent installations complete pools in glass fibre are available for sinking in the ground. Gilliam models range from the children's size of 9 ft by 5 ft to a grown-up one of 24 ft by 10 ft. The work involved for these consists of digging out the ground to receive them (the smallest need a hole 2 ft deep) and making a supporting layer of even sand to spread the weight. A soak-away allows the pool to be drained for cleaning and a concrete edging prevents too much earth being scuffled into it. Gilliam make the Diafilter units which both circulate and purify the water.

(Left) Plywood box sections allow the Purley pool to be extended in both directions. It will fold for storage.

(Below) The Swimette pool also folds up for winter storage.



In rather another class are the swimming pools for country mansions, though even these can be built by home labour. Estimated costs for the material alone (including pump and filter) for a two-depth pool 30 ft by 13 ft made in reinforced concrete are £250. More elaborate filter units for large pools can cost £212 alone.

Apart from the initial labour of digging out—the £250 pool requires a hole 30 ft by 13 ft by 9 in at the shallow end and 3 ft 9 in at the deep end, the excavated material being used to make a bank giving a minimum water depth of 2 ft 9 in—there is the continual task of keeping the pool clean for use. Water very soon becomes stagnant, leaves and debris accumulate and algae grow with remarkable rapidity. A small electric pump housed at one end will draw water through a strainer and circulate it, but a filter must be inserted to remove the debris.

A simple form of filter is in the shape of an inverted truncated cone arranged to form a cascade and sited at the opposite end to the pump so that good circulation is achieved. Within the cone of the filter are layers of sand and gravel held on a grid so that the cleaned water cascades out at the bottom into the pool again. The cascade also helps to keep the water oxygenated and therefore clear. Provision must be made for cleaning the sand surface periodically either by renewal or by back flushing to waste, using the circulating pump and a reverse valve system.

Floating debris can be dealt with reasonably easily without resort to expensive mechanical means but the growth of algae and plant life, not to mention bacteria, is another matter. Chemical means have to be resorted to for these, the most usual involving the use of chlorine. Unfortunately, an overdose of chlorine can be very harmful to the users of the pool so a regular test has to be carried out to check the contents. Devices can be supplied for the purpose. One method of addition is by using a commercial bleach or cleaner containing chlorine, either stirring in at night so that the pool will be usable again in the morning or by a steady drip (carefully adjusted) feeding into the filter or some other point of the circulation system.

An alternative to the liquid form of bleach (which has for its active material sodium hypochlorite) is pellet material of calcium hypochlorite. Where the water is very hard there is a tendency for calcium deposits to settle out which can be counteracted by the addition of hydrochloric acid to keep the pH of the water at the right figure. This implies that the right figure must be known and that there is some means of checking it. If a sand filter is used some aluminium sulphate should also be added.

The whole operation tends to make one wonder whether it is a swimming pool or a chemical laboratory. The proposal that an occasional handful of copper sulphate (which is poisonous) is sufficient, is frowned upon by the pundits.

From America comes the Simplex automatic chlorinating unit that works on quite a different arrangement. Salt is added to the water in amounts too small to be tasted and the circulation circuit includes an electrolytic cell. Electrolysis of the water produces sodium hypochlorite at a controlled rate maintaining the chlorine level in the pool at the correct figure of about 2 to 5 parts per million. The cell is simple in form and without a diaphragm. To resist corrosion the electrodes are made of platinum-titanium which have a very long life. The difficulties of handling bleach are eliminated and the amount of acid required is also reduced. Operation is continuous and fully automatic.

The Swimette is made by Gush and Dent Limited, Alresford, Hants; Purley pools by the Purley Timber and Trading Company Limited, 13 Godstone Road, Purley, Surrey. Gilliam and Company Limited are also at Purley, and the Simplex Manufacturing Company is at 1180 3rd Street, Oakland, California, USA.

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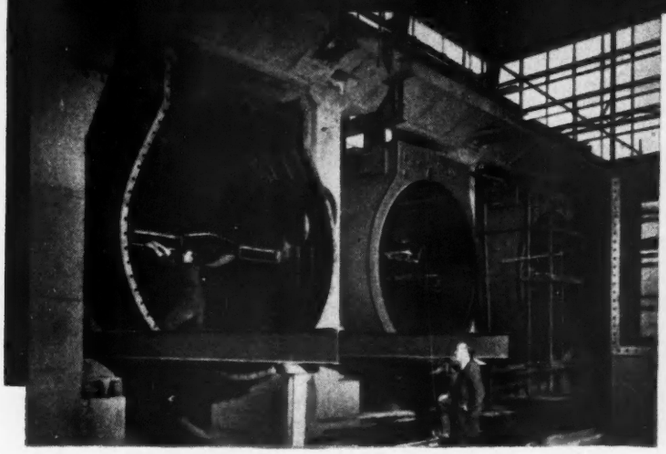

A general view of three condenser shells in position at Berkeley.

The entire turbine-house heat exchange equipment for the new power station at Berkeley is being supplied by the AEI Turbine-Generator Division, and manufactured at their factory at Glasgow.

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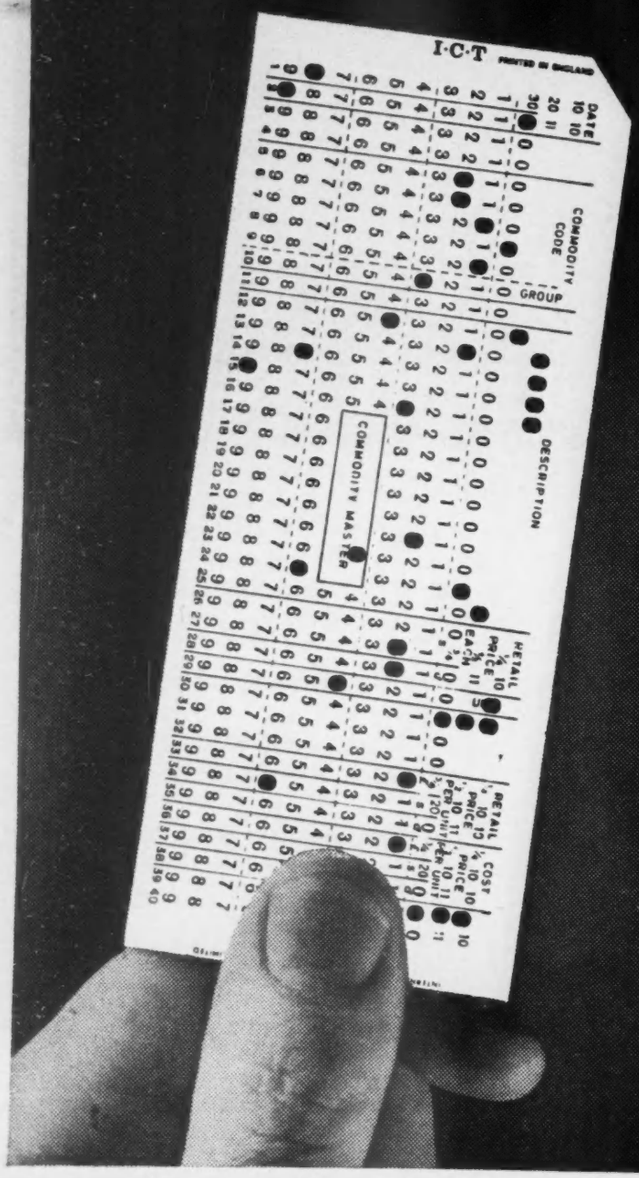

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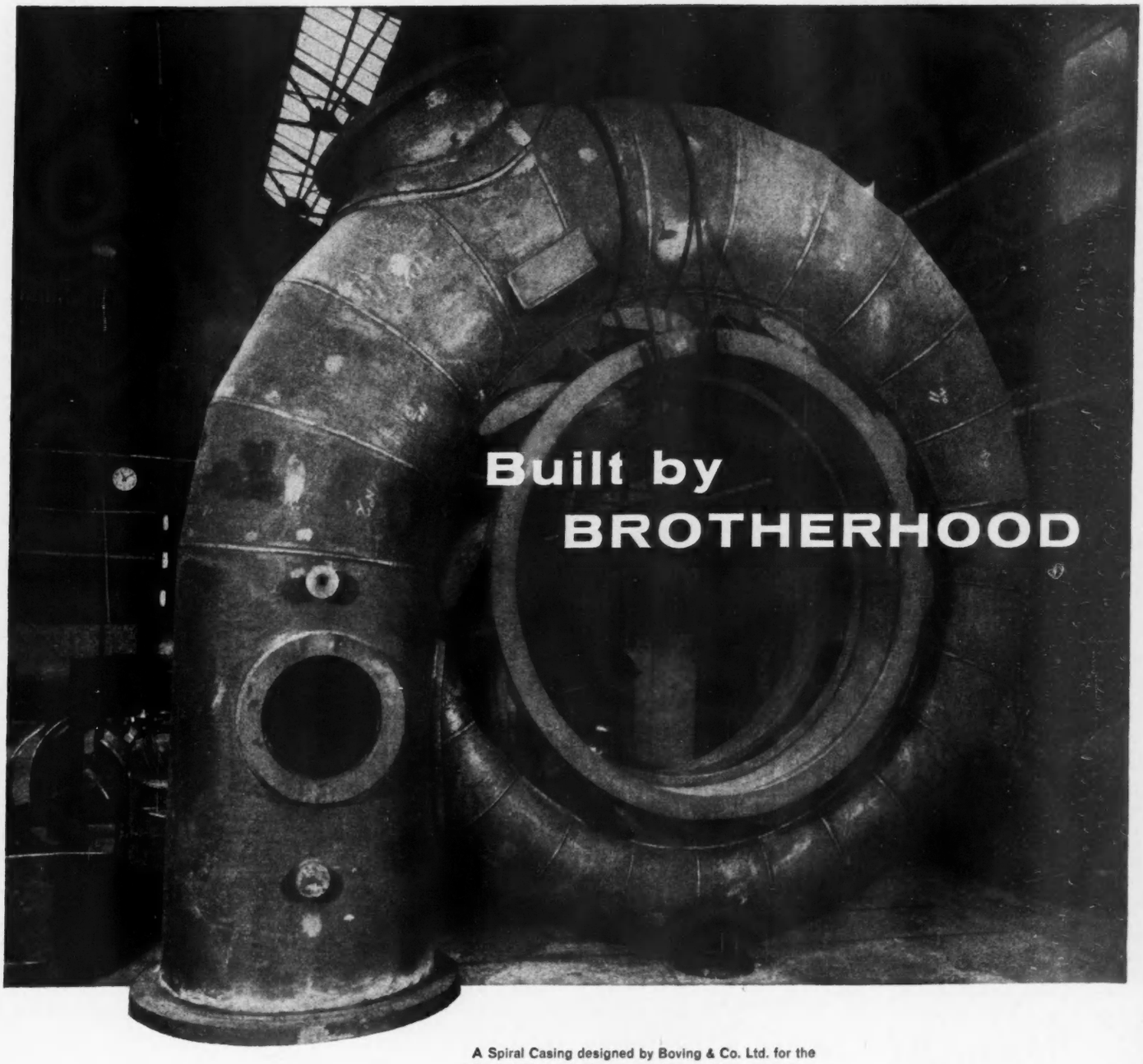

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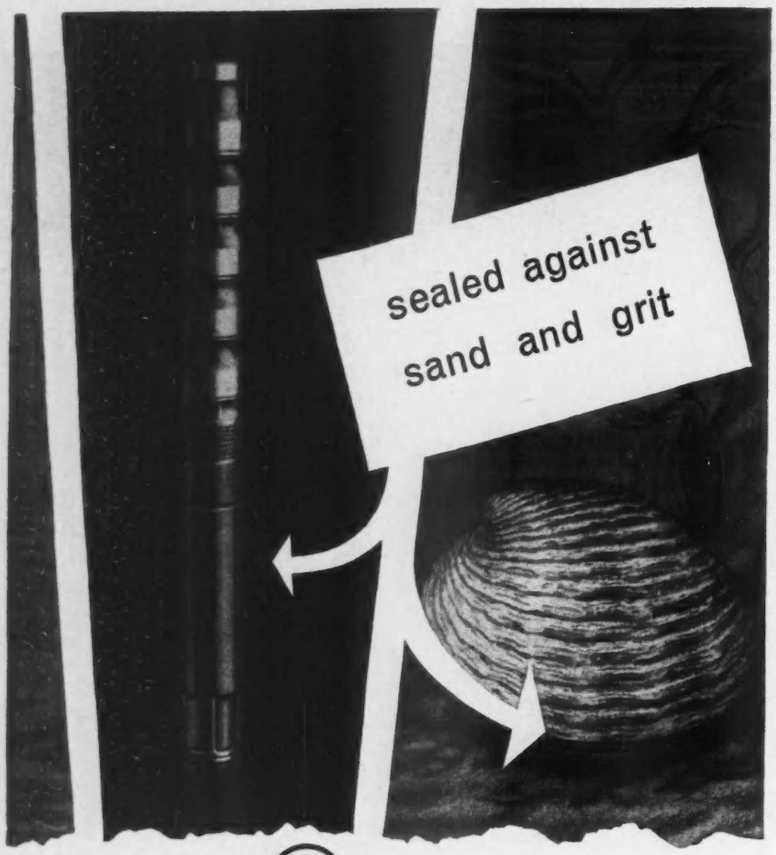

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Max. Continuous rating BSS. 649 (1958), B.H.P. and R.P.M.	16 @ 1,800	36 @ 1,800	55 @ 1,800	82 @ 1,500	113 @ 1,800	135 @ 1,800	160 @ 1,600
Continuous rating at 1,500 r.p.m.	14	30	46	82	105	121	152
Automotive rating, B.H.P. and R.P.M.	17½ @ 1,800	50 @ 2,500	80 @ 2,600	100 @ 1,750	130 @ 2,000	155 @ 1,900	200 @ 1,900
Max. Torque lbs./ft. and R.P.M. at Automotive rating	54 @ 1,500	120 @ 1,600	184 @ 1,500	322 @ 1,200	430 @ 1,200	515 @ 1,000	625 @ 1,000
No. of Cylinders	2	4	6	6	6	6	6
Cylinder Capacity, cu. ins. and (litres)	85·1 (1·39)	170·2 (2·78)	255·3 (4·18)	481 (7·88)	600 (9·83)	691 (11·33)	691 (11·33)
Cylinder Bore, ins. and mm.	3⅝ (92·1)	3⅝ (92·1)	3⅝ (92·1)	4⅛ (104·8)	4¼ (120·7)	4¼ (120·7)	4¼ (120·7)
Stroke, ins. and mm.	4⅛ (104·8)	4⅛ (104·8)	4⅛ (104·8)	6 (152·4)	5⅝ (142·8)	6½ (165·1)	6½ (165·1)

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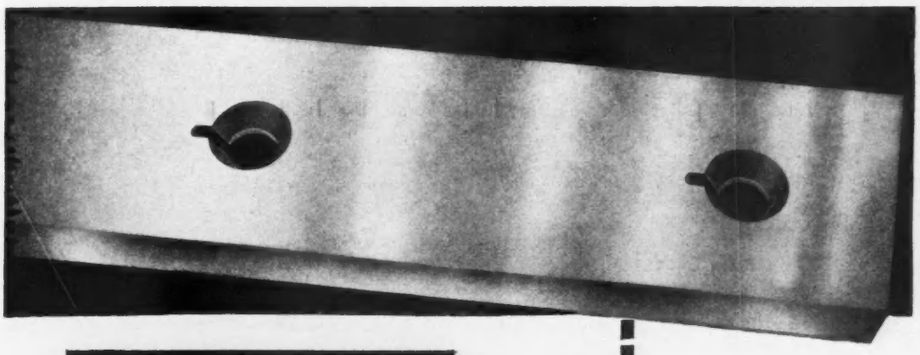

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immersion in Derv at 212°F for 200 hours

air temperatures of 1–178°C

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And they save up to 50% in initial cost!

Tecalemit Nylon Tubing almost halves fitting times; is free of internal abrasive scale; resists shock, even below -70°C; resists most solvents, corrosion and fungal attack; is unaffected even by strong ultra-violet light, and form-stable over a wide temperature range.

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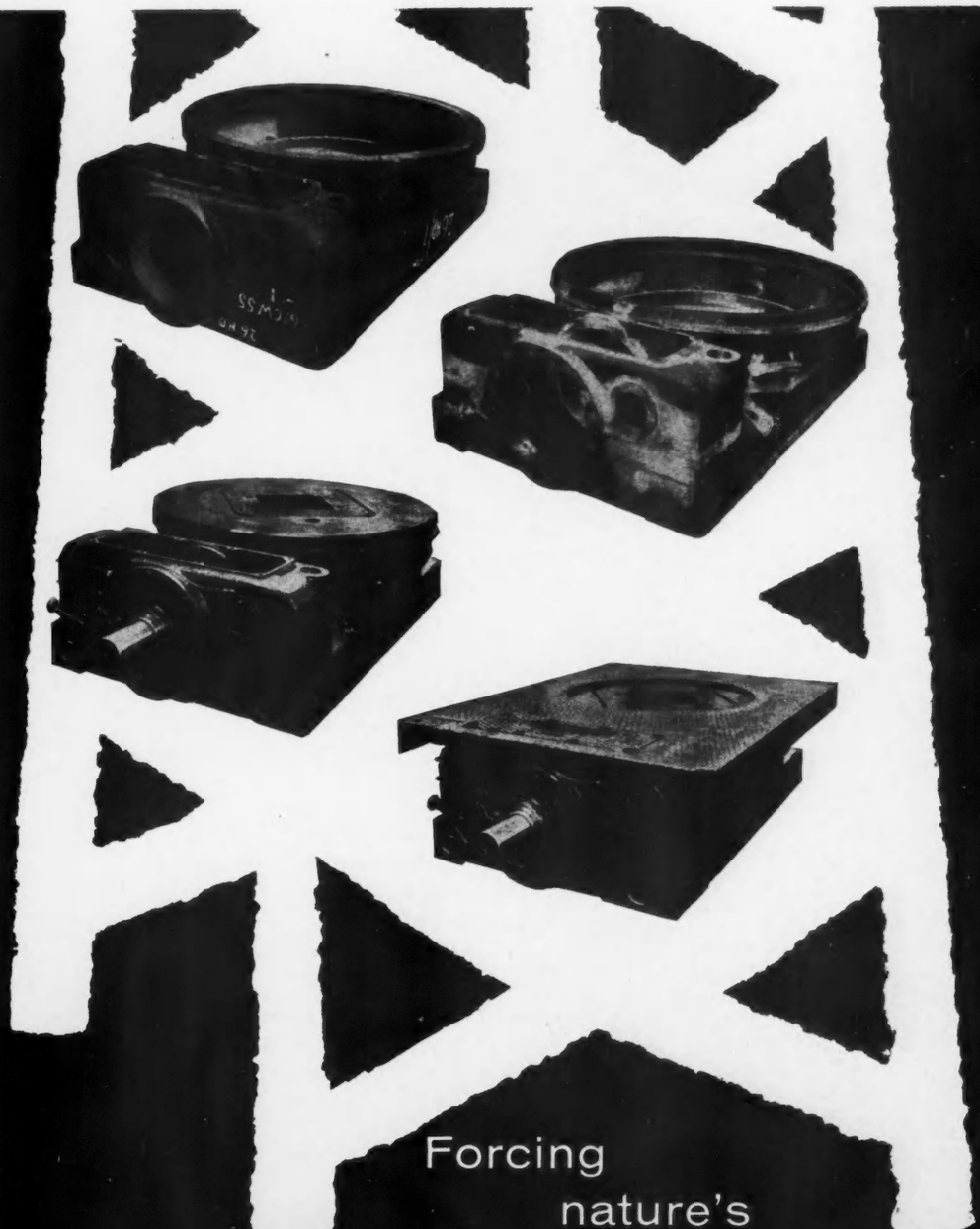

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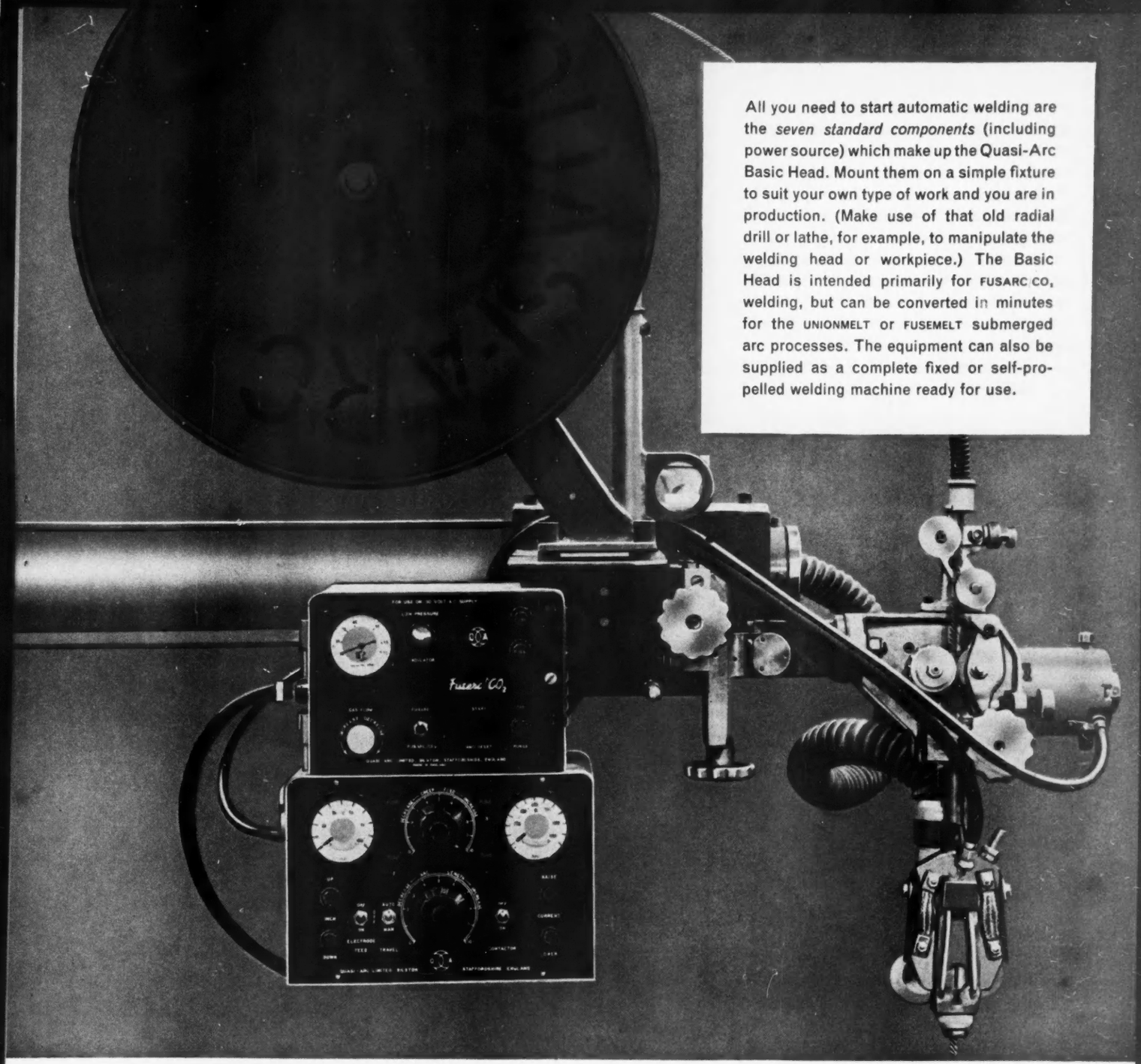

All you need to start automatic welding are the *seven standard components* (including power source) which make up the Quasi-Arc Basic Head. Mount them on a simple fixture to suit your own type of work and you are in production. (Make use of that old radial drill or lathe, for example, to manipulate the welding head or workpiece.) The Basic Head is intended primarily for FUSARC CO, welding, but can be converted in minutes for the UNIONMELT or FUSEMELT submerged arc processes. The equipment can also be supplied as a complete fixed or self-propelled welding machine ready for use.

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3 REASONS why leading mobile and industrial equipment manufacturers specify . . .

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Without removing the pump from its housing and without disconnecting hydraulic lines, VICKERS High Performance Vane Pumps can be completely overhauled by simply inserting a replacement pumping cartridge. The whole operation takes only TEN MINUTES.

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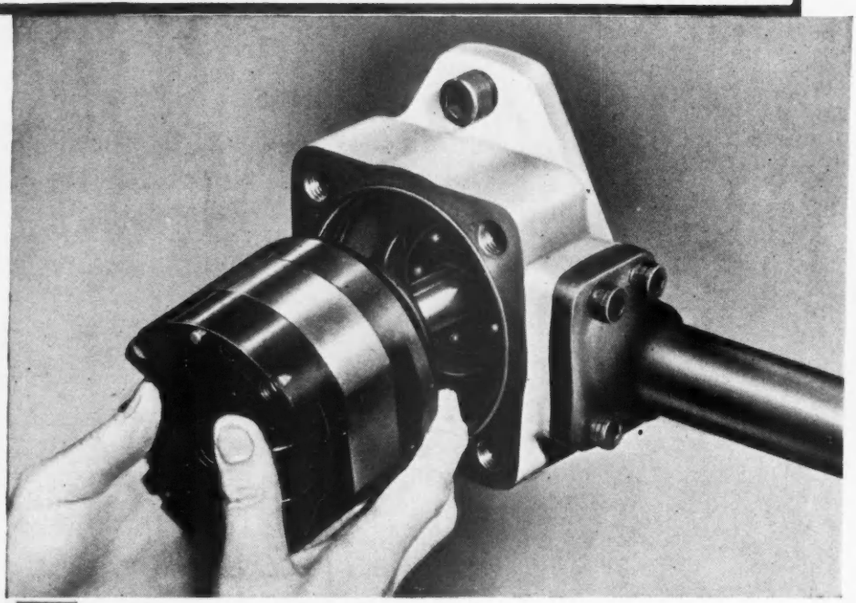

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VICKERS High Performance Pumps meet the demand for increased work from smaller, lighter and more reliable components.

The range of VICKERS High Performance Vane Pumps — now manufactured in Britain in capacities up to 100 gallons per minute — are being increasingly used by the leading manufacturers of mobile and industrial equipment. Amongst the firms specifying these pumps is the CATERPILLAR TRACTOR CO. LTD.

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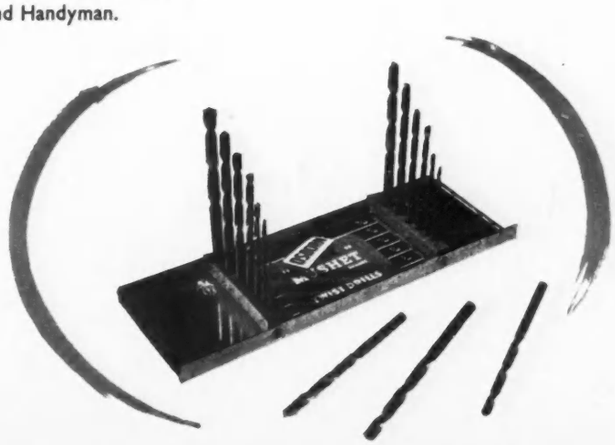

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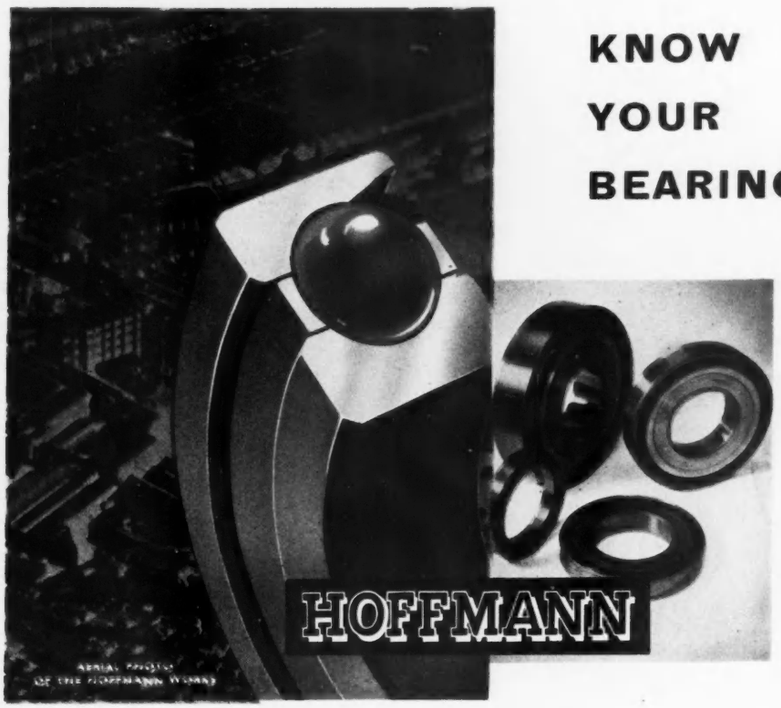

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This bearing, designed about 35 years ago, is similar to the single row ball journal bearing except that the outer race is cut-away around one side. This permits the use of a one-piece cage with more balls than in the ball journal bearing.

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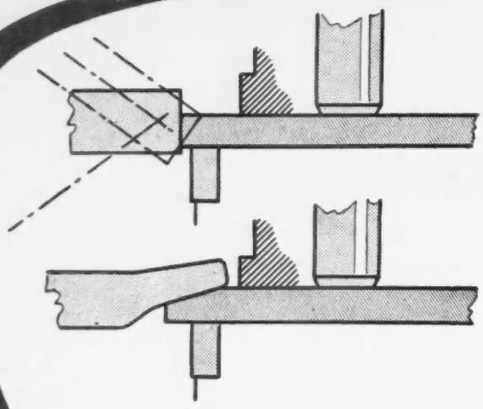
PLATE EDGE PLANING AND ROTARY SHEARING

JACK TYPE CLAMPING MACHINE



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with speed and efficiency on the

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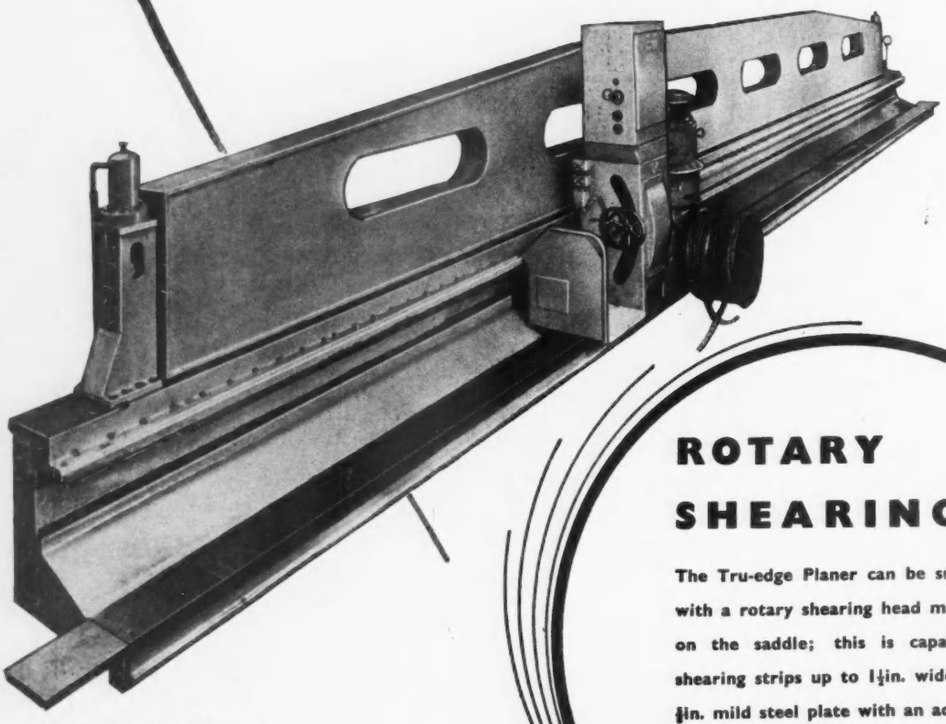
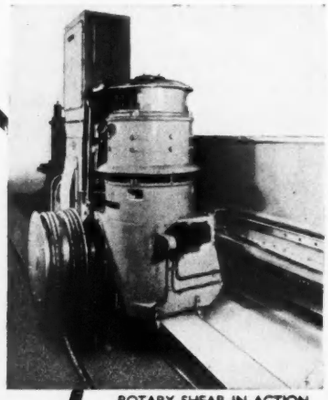
This planer, made in lengths of 25, 30, 35 and 40 feet, handles plates up to 2in. thick with speed and accuracy, and where thicker plates, or bundles of plates require edge planing we can provide a motorised tool box with a vertical rise of 6in. for progressive planing. Profile tools can be used in either case, or swivelling action can be provided for planing top and bottom bevels up to 35 deg. above or below the centre line. A special planing tool is available for cutting long bevels. In design and construction the Tru-edge Planer is highly modern in every respect and it will provide many years of excellent service. We will be pleased to supply technical information.



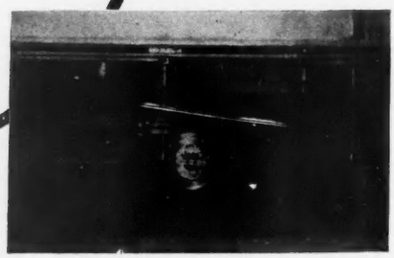
BEAM TYPE CLAMPING MACHINE

ROTARY SHEARING

The Tru-edge Planer can be supplied with a rotary shearing head mounted on the saddle; this is capable of shearing strips up to 1¼in. wide from ¾in. mild steel plate with an accuracy of 0·01in. in 40 feet. Its operation is about forty times faster than gas cutting, and less expensive.



ROTARY SHEAR IN ACTION



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These narrow angle gears were designed and developed by ENV in co-operation with D. Napier & Son Ltd for the V-drive units used with Deltic engines of 3,100 s.h.p. The gears are of case hardened alloy steel, and the teeth are profile ground to provide the accuracy essential at the high peripheral speeds attained.

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ENV engineers will be pleased to advise on problems associated with gears and drives, especially where bevel gears are used.

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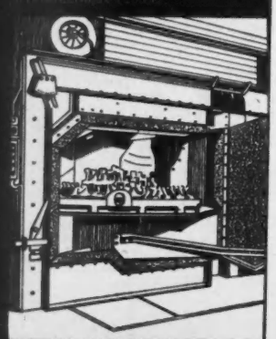

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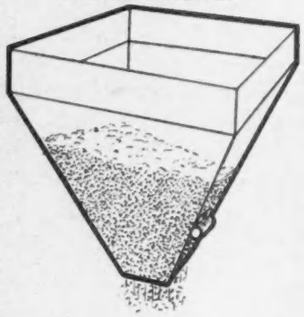
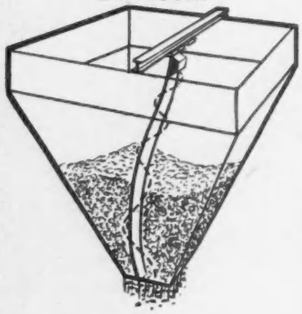


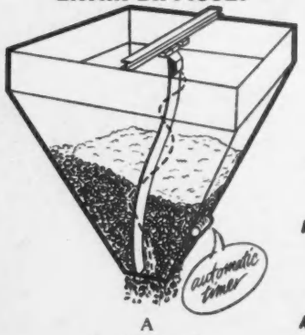
The installation of an external vibrator to a steel hopper.

DIFFICULT



The vibrating reed for application where external vibration is impractical due to structural or other difficulties and if the bunker is made of concrete.

EXTRA-DIFFICULT



A combination of internal and external bunker vibration. Where the external vibrator is timed for 'on and off', the vibration frequency, on slowing down, goes through the natural resonance of the bunker, irrespective of load material contained.

trouble-free bunker discharge

The primitive, inefficient method commonly used for clearing material which sticks in a storage bunker is by applying a sledge hammer to the side of the hopper. This is a form of low frequency, uncontrolled vibration. When vibration is applied at the *correct* frequency, the *correct* amplitude and the *correct* point of application, almost any material can be satisfactorily discharged.

SINEX has the experience with a wide variety of materials and a wide range of hopper designs to recommend how vibration should be applied effectively to solve *your* particular problem.

The three examples illustrated show three different combinations which are typical of many applications, but even these, whilst using the same type of unit, can only be effective if the types of unit themselves are placed in the correct position and have the correct frequencies and amplitudes of vibration, to suit the characteristics of the material to be discharged.

It would pay you, therefore, to make use of our experience and to consult us on your particular problem.

Send for relevant details and information sheet.

These are some of the many materials which we have handled satisfactorily and ensured trouble-free bunker discharge: Pulverised and small coal, iron ore, coke, lime, flour, grain, grist, foundry sand, soda ash, cullet, sand, gravel, granite chips and all road stone materials.

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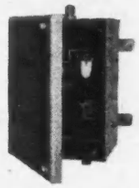

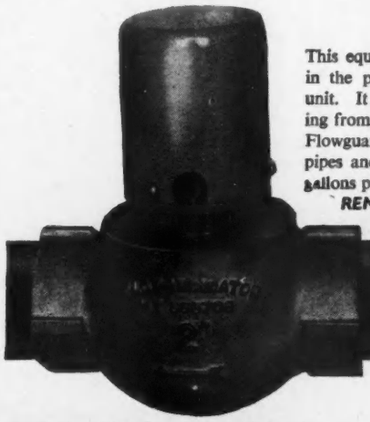

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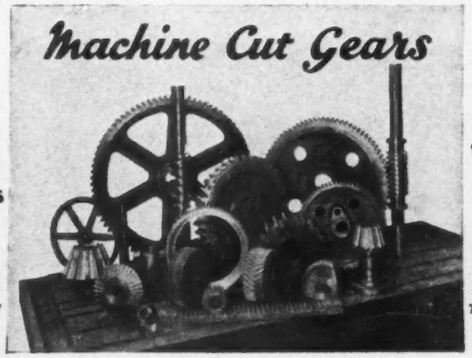

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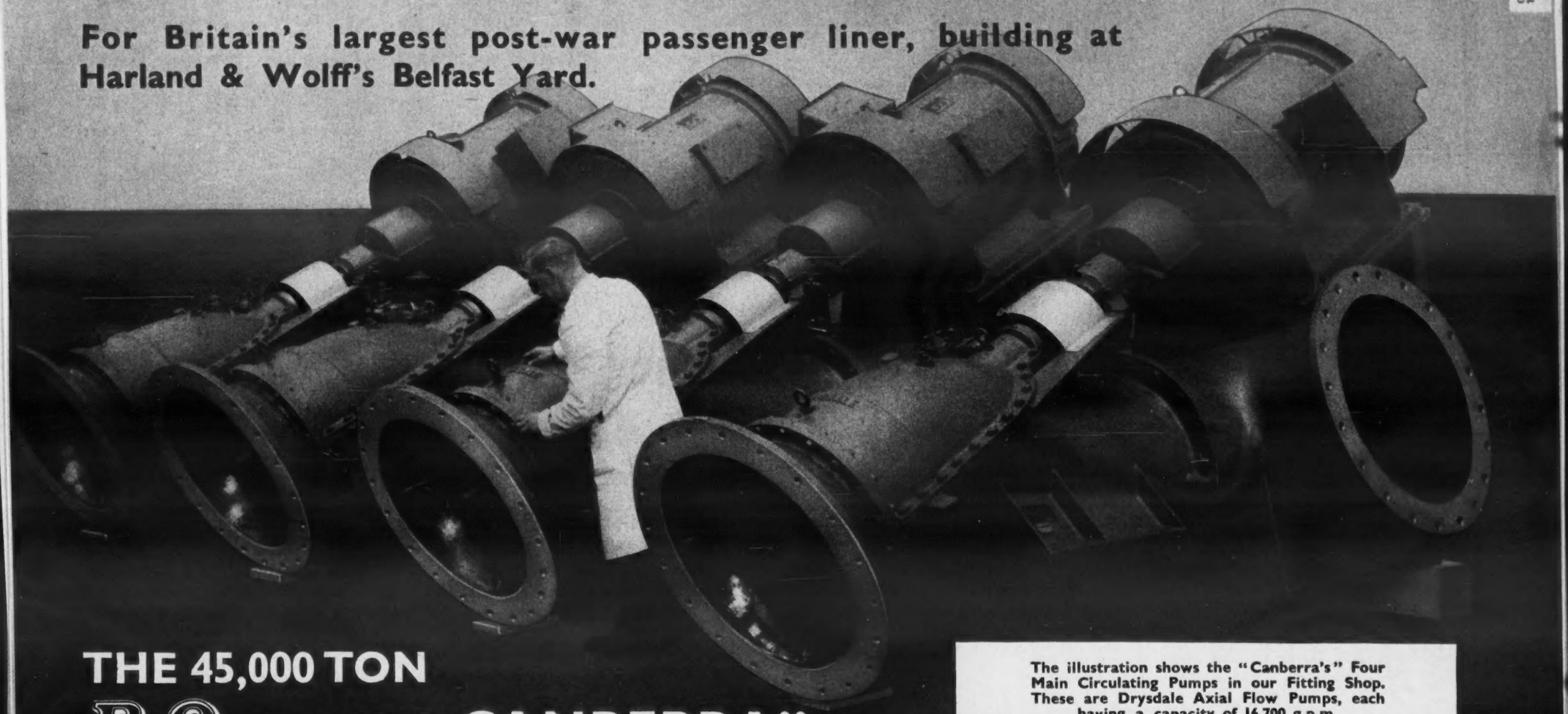

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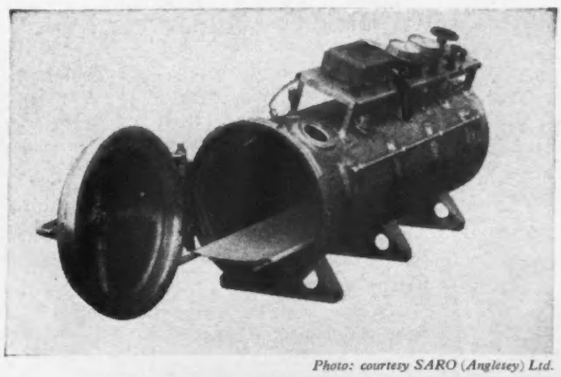

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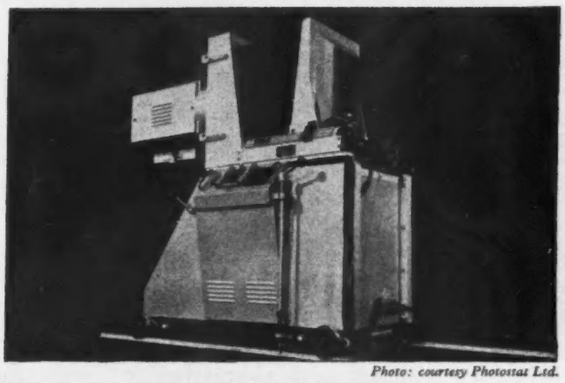

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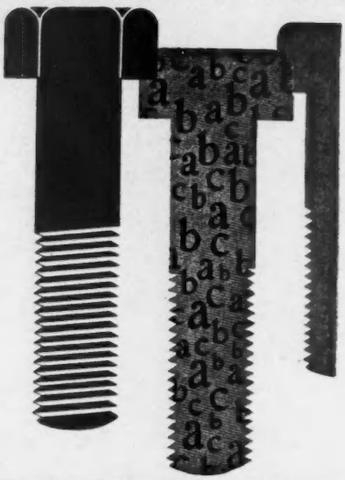

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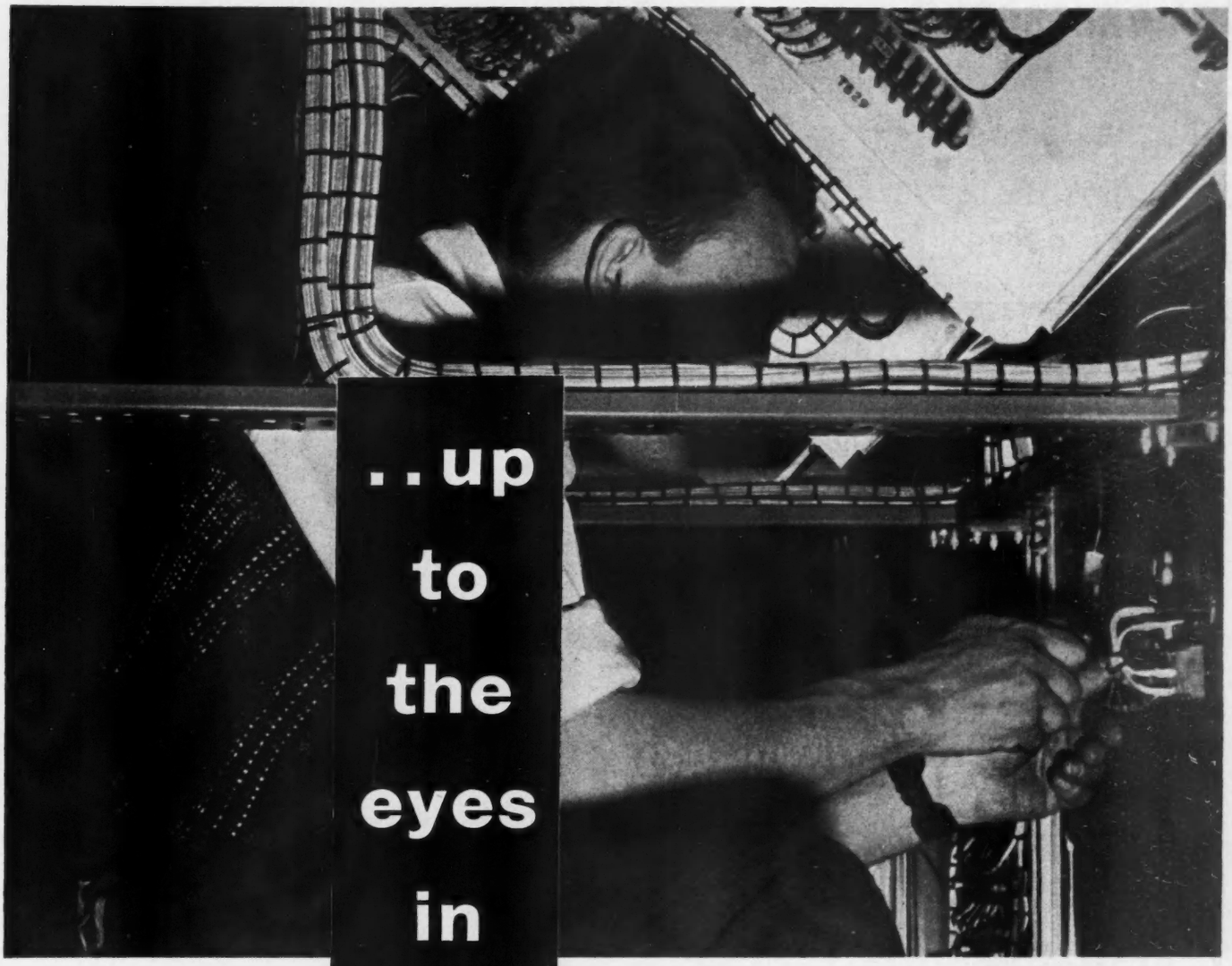

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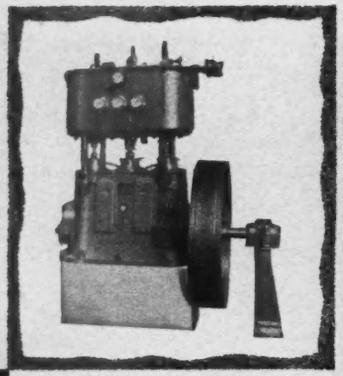

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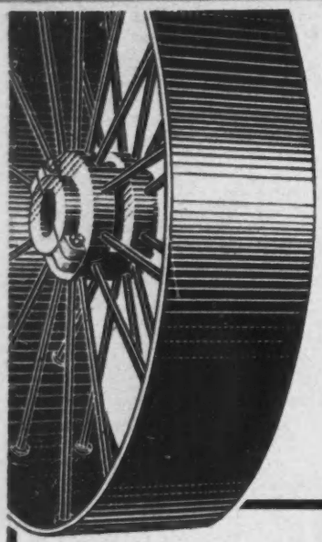

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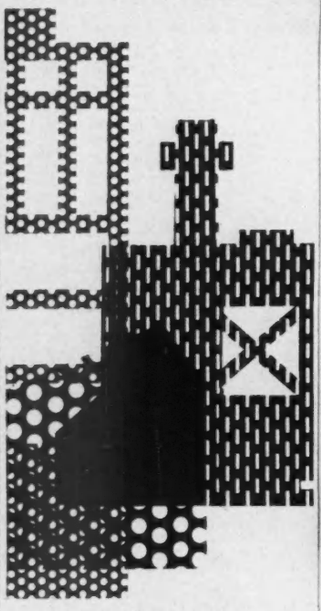

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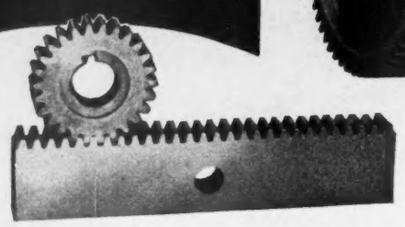

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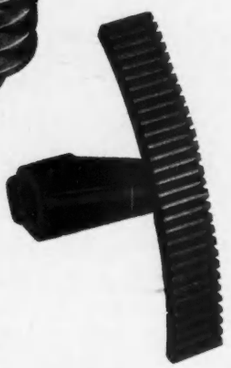

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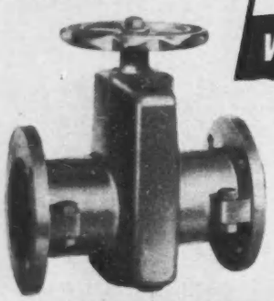

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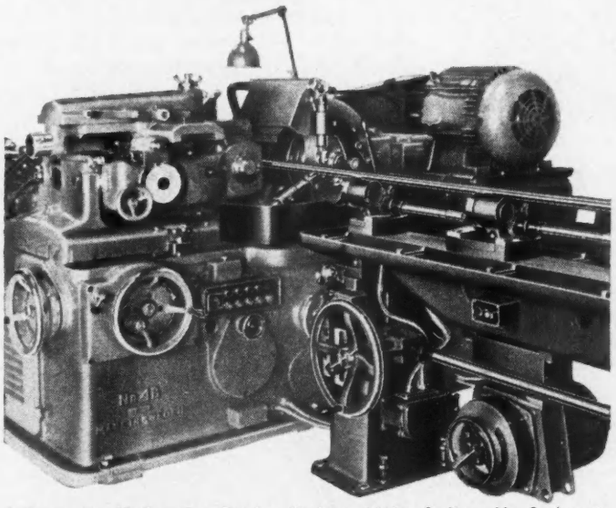

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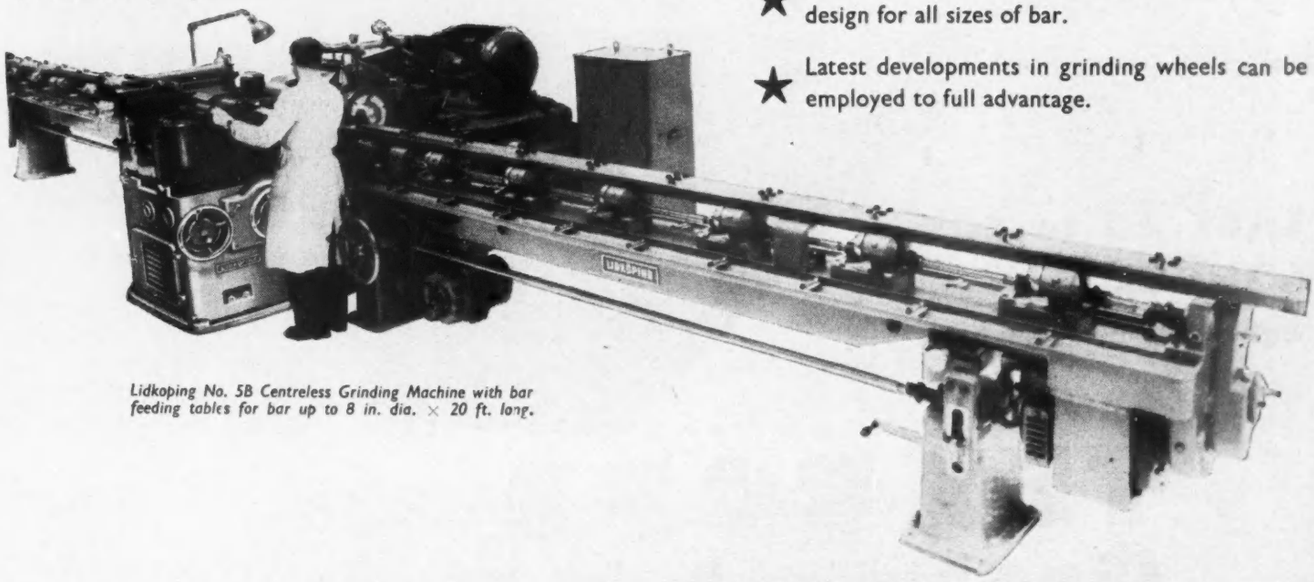

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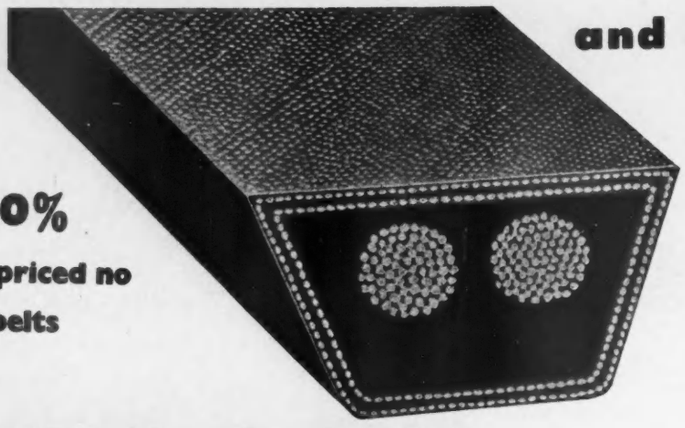

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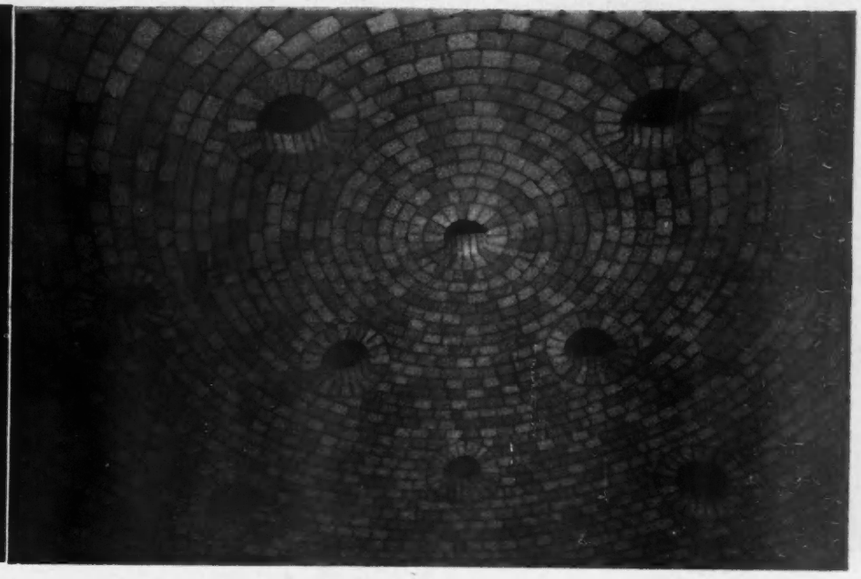

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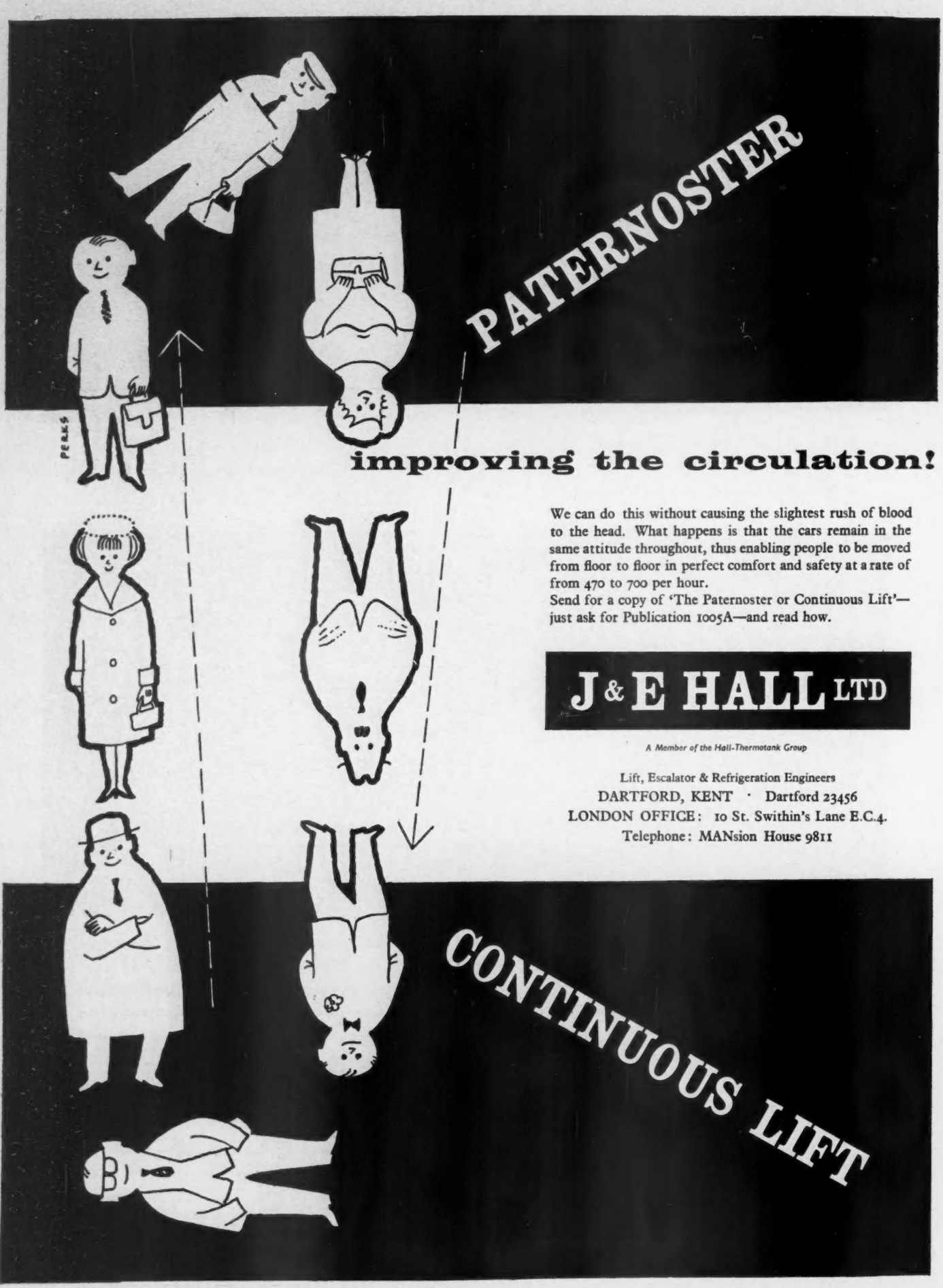

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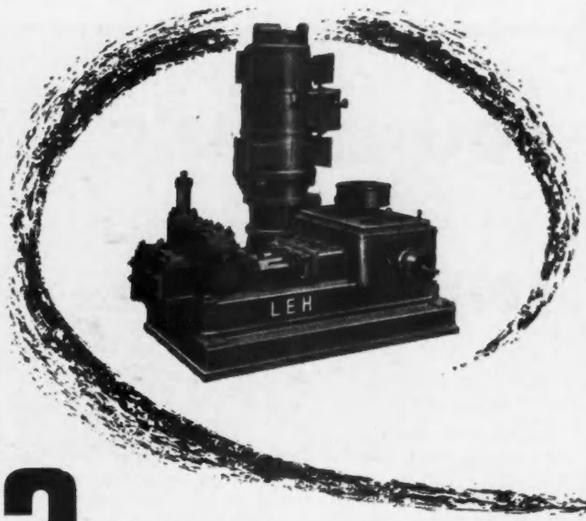

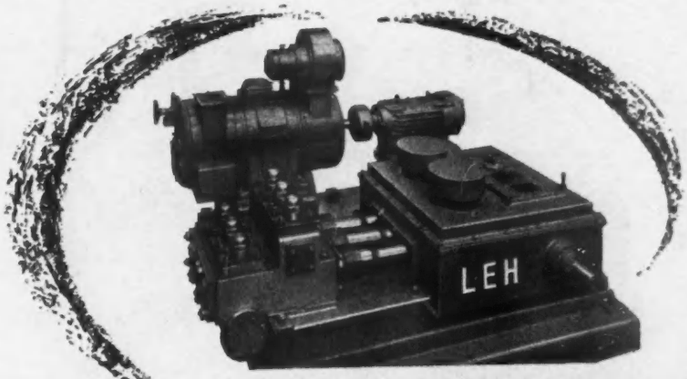

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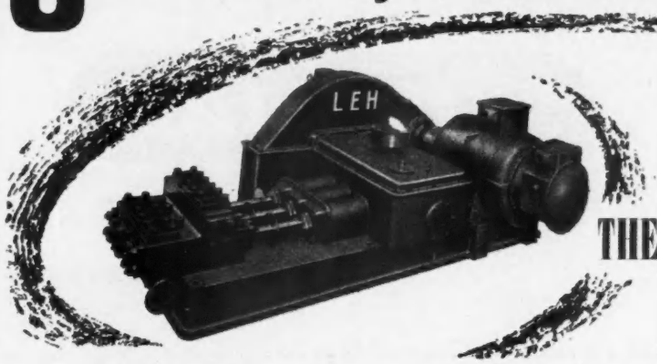

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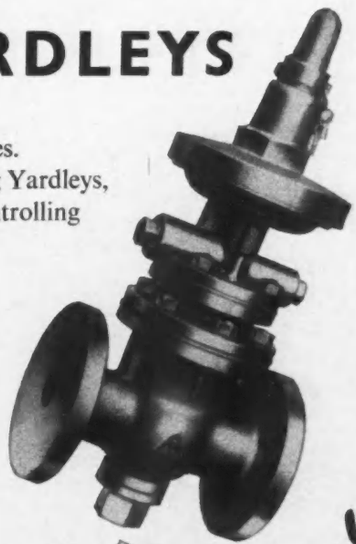

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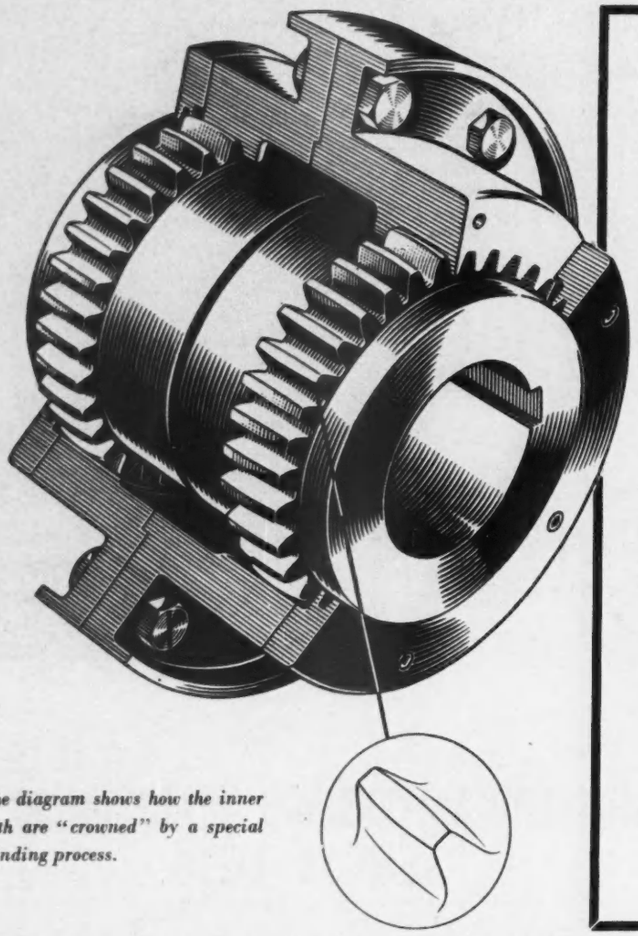

The diagram shows how the inner teeth are "crowned" by a special grinding process.

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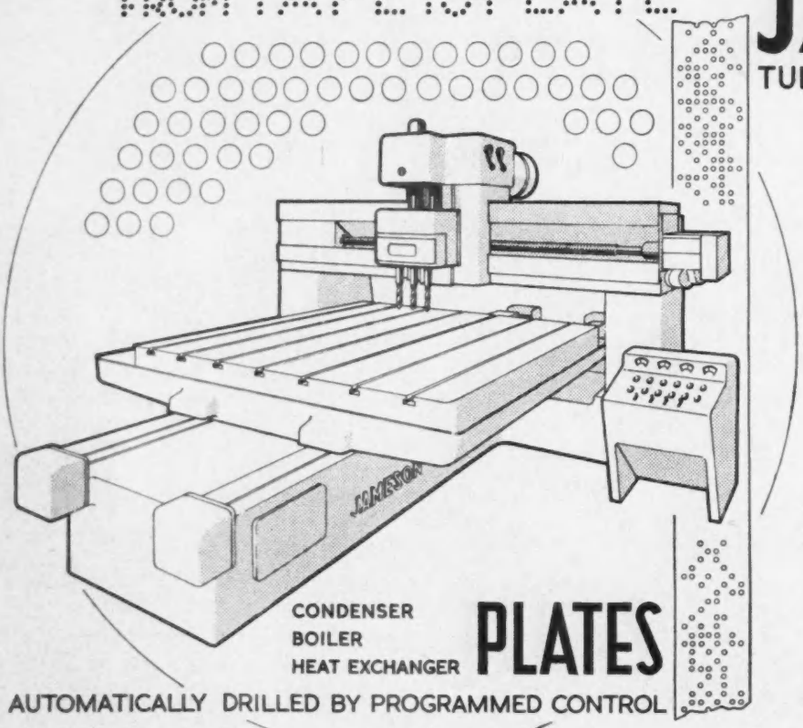

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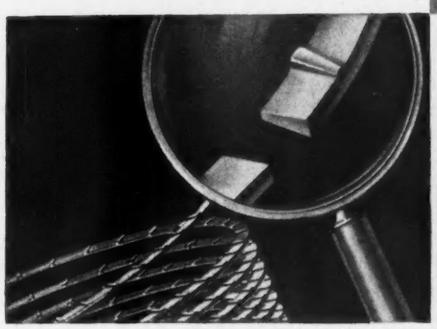

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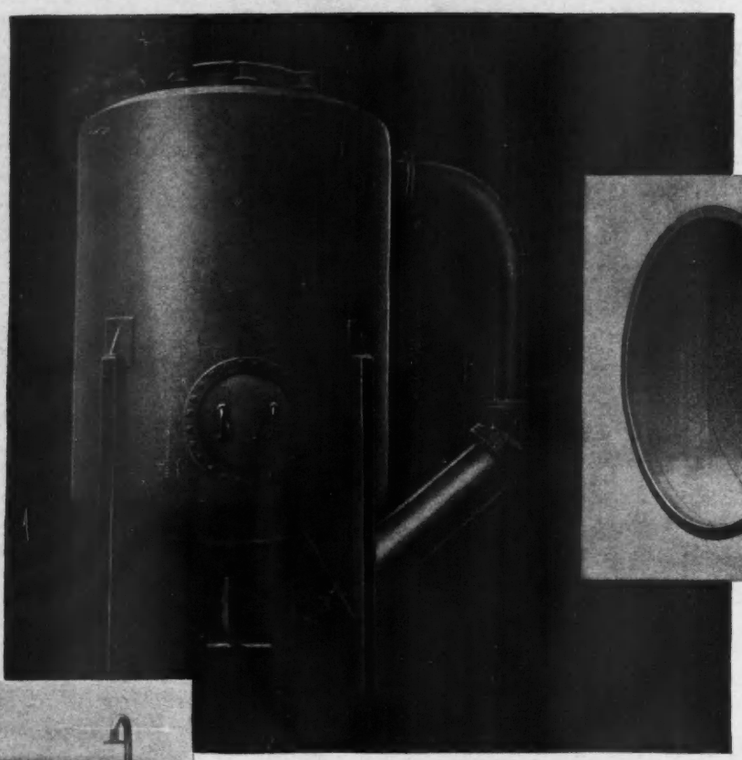
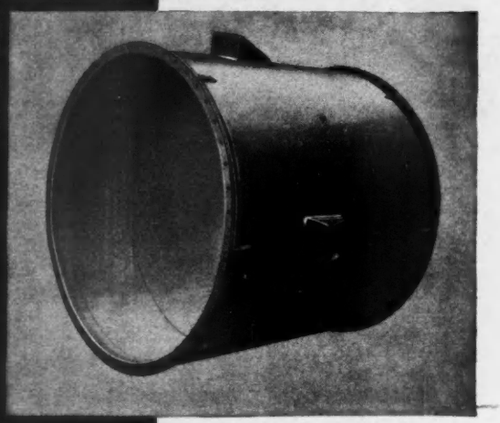
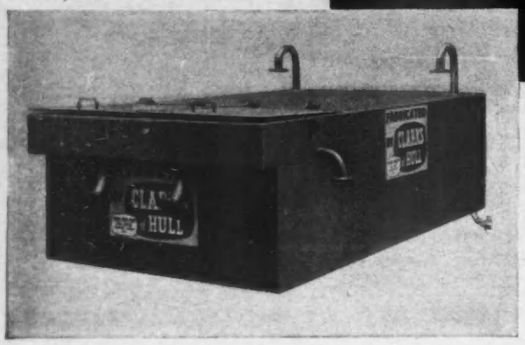


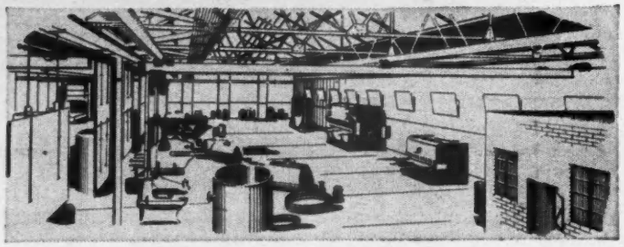
1,000 gall. kettle in ¼" copper. Lynx Quasi-arc welded.



Stainless steel vessel with mild steel jacket

12,000 gallon water separator





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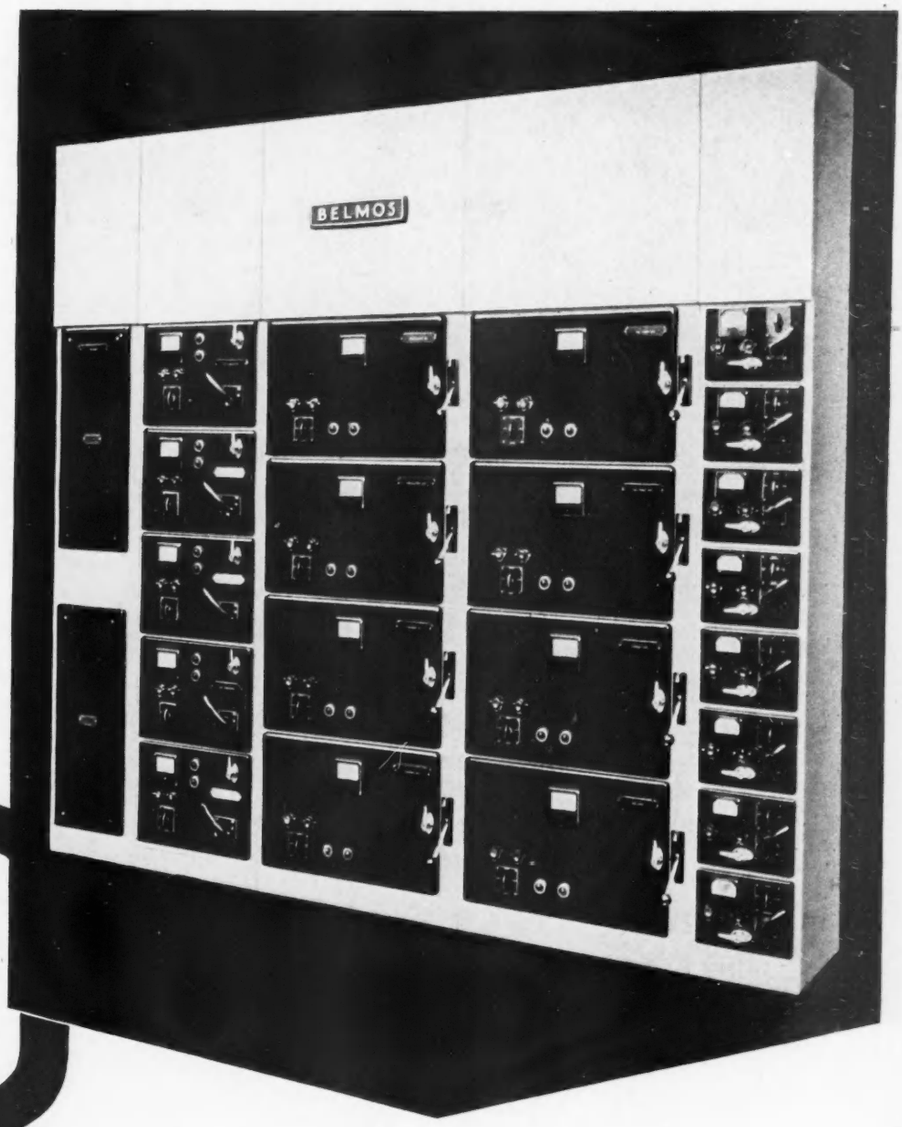
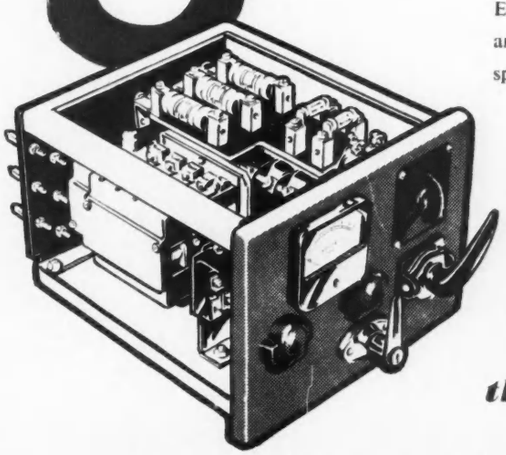


8-tier for small motor starting

The Belmos ' H ' range eight-tier cubicle can accommodate eight direct-on-line starters suitable for the control of squirrel-cage motors up to 7½ h.p. at 440 volts. Each starter is fitted with a load-breaking isolating switch and is housed in a plug-in chassis for accessibility and speed of servicing.



This unit is fully described in leaflet K 500 which will be sent on request.

* The cubicles are designed to be grouped into flush-fronted control boards and, with the provision of simple local and remote control arrangements, are eminently suitable for group control of continuous processes. They can be lined up with the four- and five-tier cubicles of the G range, which house larger starters for motors up to approximately 90 h.p. at 440 volts.

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